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Applied Nutrition

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THIS discussion concerns the social and public health aspects of applied nutrition rather than its application in therapeutics or dietetics.

Doctors and public health officials are interested in nutrition for many reasons. Lack of adequate food is the sole cause of certain diseases, often called deficiency diseases, and evidence is accumulating every year that these diseases, at least in their early forms, exist in Canada. Inadequate food is an important predisposing cause of many other diseases, such as tuberculosis. Poor dietary habits among groups of people seem to increase the amount of blindness, and the amount of various signs of aging; premature death is also observed among these groups. Lack of adequate food may reduce vigour and interest in work, which has an effect in industries. Mental alertness may also be affected, and this is important in many ways including the education of children. A few extra foods during pregnancy make a great difference to the health of mother and child.

In the twenty or thirty years of modern nutritional discoveries there is, therefore, ample evidence that proper nutrition will reduce the burden of disease. The application of this knowledge to all classes of people seems likely to produce effects as startling as the advances in public health that were made by improved sanitation and the development of bacteriology.

These effects of applying nutritional knowledge may be expected because no country has at any time had all its citizens ideally nourished. Even in the best-fed countries, which are those with high national incomes, high

TABLE I

CANADA'S FOOD REQUIREMENTS (*a*) FOR WARTIME CONDITIONS (MINIMUM FOR HEALTH) AND (*b*) FOR ADEQUATE NUTRITION

The Requirements for *Adequate Nutrition* are calculated in per caput yearly amounts and compared with a calculated per caput yearly consumption in the United States, and the deficiency or excess expressed in percentage. Some Canadian figures of per caput yearly consumption are also given, where these are obtainable, but are less complete.

(NOTE: Various such lists could be drawn up, one item being changed to compensate for another. The Canadian requirements listed here have been calculated for adequacy in terms of known dietary factors. They also have the advantage of being based on actual shopping lists which pay attention to the planning of menus and to palatability as well as to adequacy.)

	Annual Canadian Requirements for Wartime (Minimal) (*millions of pounds*)	*Annual Canadian Requirements for Adequate Nutrition* (*millions of pounds*)	*Annual Canadian per caput Requirements (Adequate)* (*pounds*)	*Annual United States per caput Consumption 1936-40*[1] (*pounds*)	*Deficiency or Excess in per caput Consumption*		*Annual Canadian Disappearance per caput (1935-9)*[5] (*pounds*)
					Per cent Deficient	*Per cent in Excess*	
Fluid milk.....	4,613	6,148	539 lbs. (216 qts.)	370 lbs. (148 Can. qts.)	31		420 lbs. (168 qts.)
Plus some cheese	....	....	....	....	..	..	4 lbs.
Potatoes.....	2,081	2,112	185 lbs.	149 lbs.	20[2]		198 lbs.[3]
Green vegetables	436	1,112	98 lbs.	73 lbs.	26		?
Root vegetables.	1,428	1,594	140 lbs.	?	?		?
Dried vegetables	139	139	12 lbs.	12 lbs.	..	..	?
Tomatoes.....	894	1,192	105 lbs.	50 lbs. (?)	52 (?)		18 lbs.[3, 4]
Fresh fruit (¼ citrus)	867	1,748	153 lbs.	127 lbs. (?)	17 (?)		Citrus 21 lbs.[3, 4] Non-citrus 53 lbs.[3, 4]
Dried fruits.....	281	280	25 lbs.	?	?		8 lbs.
Eggs (millions of dozens).....	163	247	22 doz.	24 doz.		9	21 doz.
Meat, poultry, fish.....	659	1,413	124 lbs.	134 lbs.		8	151 lbs.
Bacon and/or salt pork....	96	153	13 lbs.	?	?	?	11 lbs.
Flours and cereals	629	705	62 lbs.	196		3	195 lbs.
Bread.....	2,066	1,462	128 lbs.	total cereals			total cereals
Butter.....	384	395	35 lbs.	67		18	31 lbs.
Other fats.....	243	247	22 lbs.	total fats			14 lbs.
Sugar.....	258	270	24 lbs.	75		63	92 lbs.
Other sweets....	251	251	22 lbs.	total sweets			21 lbs.

[1]Adapted from Cummings, "The American and His Food", and other sources.
[2]These percentages, based on American consumption, may not be significant for Canadian agriculture, depending on how much of the last column is produced in Canada.
[3]Marketing losses on 28 per cent have been deducted.
[4]Estimate for year 1940 only.
[5]Based on figures from the Agricultural Statistics Branch, Dominion Bureau of Statistics

standards of living, and reasonably good distribution, about one quarter of the population seem to have failed to get the foods essential for radiant health. Many countries, such as India, seem to have a majority of the population suffering from malnutrition.

We cannot afford the toll of disease, inefficiency, blindness, and death which is suggested by this situation. From an economic as well as social welfare viewpoint steps should be taken to ensure that all sections of the population use enough of the right kinds of food, prepared in the right way. This goal is not easy to attain. Efforts to raise income levels are important, but are not enough. Education is slow and uncertain unless at the same time other steps are taken to see that the new knowledge can be applied. In other words, every part of the food picture must receive some attention. Only then will it be really easy for all Canadians to be adequately nourished.

WHAT IS NEEDED?

What does this entail? There should be adequate agricultural production of the desired foods in the amounts needed for adequate nutrition. Since some foods must be stored or carried over, even against off-seasons and poor yields, this storage should be such as to preserve the nutritive qualities that have been produced. Some standards must also be set up to control processed foods, in order that valuable nutrients should not be wasted, and in keeping with our goal of making it difficult for a consumer to get anything but an adequate diet. Even then there is still a big job in equitable distribution to be carried out. Finally, we come to the process of consumer education, such as in the present Canadian Nutrition Program.

It is not necessary to have all this plan for applied nutrition start at once. Indeed, some of it has already been started. But Canada is lagging behind Great Britain and the United States in developing some aspects of it which could be started anytime.

AGRICULTURAL PRODUCTION

For example, there is the question of just how much of each foodstuff would be needed to feed every Canadian adequately. While various such lists could be drawn up, the one shown in the accompanying table has the advantage of being based on practical experience in arranging menus, as well as on theoretical calculations.

The table is based fundamentally on the accepted optimal dietary standards, and the foods needed to meet them, since this optimum must be the goal of nutritionists. There is also included, however, a column giving food quantities needed for the minimal standards which we should strive to maintain even under present wartime conditions. These two columns emphasize the fact that we are obliged to share our food with Britain, Russia and other countries, but that we should not lose sight of the fact that there is a lower limit of supplies necessary for Canadian civilians, which should be maintained.

Unfortunately, the Canadian figures must be compared with average consumption in the United States, since the corresponding Canadian figures

are less complete. The last column does give some Canadian figures, calculated from some obtained through the Agricultural Statistics Branch of the Dominion Bureau of Statistics.

Clearly some increases in the available supplies of many commodities are needed in order to feed Canadians adequately. These increases are in addition to all the foodstuffs shipped out of the country, or used industrially. Steps in this direction can be taken in any crop year, but full realization of this goal may have to await the end of the war. Fortunately, steps in this direction are now being taken, although they are only a beginning. The Foods Administration of the Wartime Prices and Trade Board has long been aware of the importance of nutritional standards and of protecting supplies. The recently formed Food Requirements Committee set up under the Cabinet to guide a food policy for Canada seems to be moving in this direction. The Sub-Committee on Agricultural Policy of the Committee on Reconstruction has received nutritional representations. Progress is slow, but the pathway is clear.

OTHER STEPS NEEDED

Arranging production alone is not going to be fully effective unless other steps are also taken. Equally important, both now and after the war, is some type of price control for primary produce or some mechanism which will give farmers a more assured income and higher standard of living. In keeping with a nutritional basis for the whole food picture, some new standards would be needed to control food storage, processing and distribution, in addition to our current efforts at consumer information. Of these steps it is probable that food distribution to special groups would be the one most readily started right now.

STORAGE AND PROCESSING

Much has been achieved in the important steps of food storage and processing. Stability on storage, convenience, sanitation, ease of preparation, and other goals have been reached in many products. Unfortunately, the consumer and his health have not been considered very much in reaching these goals, and the retention of the original nutritive value is only now receiving attention. This will mean some changes in food industries.

The future of food storage is likely to see great developments in a wider use of fresh frozen foods and lockers for individual families. Dehydrated foods will also have a place after the war, although possibly not so great as some of their exponents claim. Again the question of retaining nutritive value must be kept in mind as our new goal.

Processed foods are also being examined more and more for retention of nutritive qualities, and for their actual place in a diet, in relation to other foods available. From the broad viewpoint of public health and welfare it must be made difficult for anyone not to get an adequate diet.

CONSUMER EDUCATION

A good deal of effort is now being put into educating consumers about food values. This does not refer to the often-misguided efforts of food

advertisers on behalf of their own products, but rather to careful and authoritative work by government, private, and voluntary agencies which is being coordinated into the Canadian Nutrition Program. The initiative in this program must come largely from local effort in individual communities, assisted by private agencies, local and Provincial Boards of Health, and by Ottawa. It is hoped that 1943 will see such methods of bringing information to the public widespread throughout Canada, and working closely with other voluntary community work, especially in what is called the "block system".

In view of current problems in wartime eating, and the fact that malnutrition was definitely present in Canada at the beginning of the war, it is possible that our nutritional status and then to some extent our health may actually deteriorate unless Canadians learn more about eating the right foods and how to prepare them. To help awaken Canadians to this importance of nutrition right now, and to publicize the first step toward adequate nutrition (Canada's Official Food Rules), Nutrition Services, Ottawa, has arranged with many advertisers, both food and non-food, to give prominence to these ideas early in 1943. The generous response should create some interest, which will help local groups in their efforts.

FOOD DISTRIBUTION

There is a further step in applying nutrition which is much needed in Canada right now. We cannot wait for improved economic conditions to raise our nutritional status, and even at best, that would not reach everyone. We need not wait for sufficient agricultural production in order to effect some improvements through a change in distribution. Great Britain has found that if upper-class groups are slightly restricted in the foods they get, and if lower-class groups are allotted some of the protective foods, even at less than cost, the average level of health has been raised. A similar thing was done by the Food Stamp Plan in the United States. Although this costs money, yet there is actually an ultimate saving of money in the reduction of the great burden of poor health, sickness, loss of work, bad teeth, etc., found among the large numbers who are undernourished.

Supplies of certain foodstuffs should be the recognized right of everyone in Canada. Steps are needed right now to allot supplies to welfare groups, school lunch programs, expectant mothers, industrial groups, and others. Such a mechanism would also be useful after the war to assist food distribution to settlers, refugees and for any other problems of this type which Canada might face.

"FREEDOM FROM WANT"

Our aim should be that proper foods may be adequately produced, under an assured price, carefully stored and processed, equitably distributed and properly consumed, all on a nutritional basis. Nutrition applied in this way would go far toward implementing the Atlantic Charter.

A Dietary Survey in Winnipeg

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ADEQUATE nutrition is the basis of good health. Because of this belief the Canadian Council on Nutrition in 1939 instituted four dietary surveys—one in Halifax, a second in Quebec, a third in Toronto, and a fourth in Edmonton. These surveys were conducted with a view to ascertaining the nutritional adequacy of the ordinary Canadian diet. The method used was the individual consumption method which enabled the investigators to find out how much food was consumed by each member of the family daily. These surveys confirmed the findings of the earlier study made in Toronto and reported on by McHenry, namely that there were serious deficiencies in the ordinary Canadian diet. In fact, these deficiencies showed up so markedly in the Council Surveys that the Canadian Council on Nutrition started a nutrition program in the hope that education would lead to a more enlightened diet and thus improve the health of the Canadian people.

In Winnipeg, the Housekeeper Service Committee of the Family Bureau decided to investigate the food habits of some of the families known to the Bureau in an endeavour to see how this selected group compared with the families studied in other parts of Canada. It was felt, too, that when the deficiencies were known it would be much easier to plan for more adequate dietaries. And so in February 1942, Miss Bernard, Supervisor of the Housekeeper Service of the Family Bureau, selected thirty families that she felt would be typical of the families helped by the Bureau. These families were all willing to co-operate in the survey and showed great interest in the project. It was most important to have their goodwill as the family inventory method used in this survey involves extra work and trouble on the part of the homemaker. The twenty-nine families who completed the survey comprised 165 persons or an average of 5.6 individuals. The average number of children was 3.9. The yearly income range was $948.00-$1764.00, with only two families receiving an income greater than $1500.00. The weekly income per individual was $2.59-$6.07. In sixteen families or 55 per cent of the cases the husband was on active service, many of them overseas at the time the survey was made. There were housekeepers in six families.

The work was done by volunteers who were divided into five groups, each group undertaking to collect data from six homes. Under the guidance of Miss Jean Woodside, Home Economist of the Family Bureau, they visited every home and weighed the food on hand at the beginning and at the end of the experimental period, which was ten days. They also visited the families every day, except Sunday, to collect the list of purchases for that day. The success of the

survey was largely due to the willing assistance and hard work of these volunteer helpers.

Before analyzing the data thus obtained, due allowance was made for unavoidable waste. The food was then analyzed in terms of calories, protein, calcium, iron, vitamin A, vitamin B_1, and vitamin C. These figures were compared with the Canadian Dietary Standard accepted by the Canadian Council on Nutrition in May 1942. This standard is somewhat different from the standard used in the Council Surveys of 1939. However these surveys, in all probability, will be recalculated in the light of the new standards and so it seemed wiser to use them in this survey. The main difference between the two is in the amount set for vitamin C which has been increased in the new standard accepted last spring.

Results

The results of this survey will be discussed according to the individual foodstuffs. The term adequate means 90 per cent of the standard or better; the term inadequate, between 70 and 89 per cent of the standard; and markedly deficient, under 70 per cent of the standard.

Calories: The average daily calorie consumption was 2402 or 108 per cent of the standard. Twenty-five families (86 per cent) received an adequate amount and the four remaining families (14 per cent) received an inadequate amount, with no families being markedly deficient. It would seem that the calorie intake was reasonably adequate.

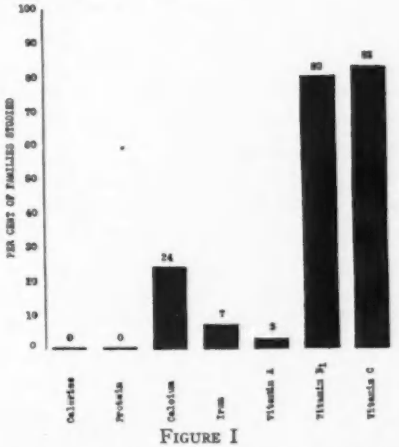

Figure I

Percentage of families studied having diets markedly deficient in the indicated food constituents
(below 70 per cent of the Canadian Dietary Standard)

Protein: The average daily protein consumption was 73 grams or 118 per cent of the standard. Twenty-five families (86 per cent) received an adequate amount and the four remaining families (14 per cent) received an

inadequate amount, with no families being markedly deficient. Generally speaking, our Canadian food habits are such that when sufficient food is eaten to cover the calorie requirements the protein requirements are also met. The results of this survey proved no exception to the general rule.

Calcium: The average daily calcium consumption was 0.89 grams or 89 per cent of the standard. Ten families (35 per cent) had an adequate intake, twelve families (41 per cent) were inadequate, and seven families (24 per cent) were markedly deficient. As one would expect, the calcium level was raised or lowered in direct proportion to the amount of milk consumed. Those families whose intake of milk was equal to or better than one pint per person per day had an adequate consumption of calcium. Those consuming less were deficient in calcium.

Iron: The average daily iron consumption was 12 mg. or 117 per cent of the standard. Twenty-two families (76 per cent) had an adequate intake. Five families (17 per cent) were inadequate while two families (7 per cent) were markedly deficient. It would seem that the iron intake was reasonably adequate.

Vitamin A: The average daily vitamin A consumption was 6035 I. U. or 152 per cent of the standard. Twenty-five (90 per cent) had an adequate intake, two families (7 per cent) were inadequate, and one family (3 per cent) was markedly deficient. On the whole the consumption of vitamin A was very good, some families actually consuming two or three times the amount in the standard.

Vitamin B_1 (thiamin): The average daily vitamin B_1 consumption was 0.66 mg. or 57 per cent of the standard. Only one family (3 per cent) had an adequate intake, five families (17 per cent) were inadequate, and twenty-three families (80 per cent) were markedly deficient. Now that both Canada Approved bread and flour are on the market there is no doubt that those families who use these two products will materially improve their situation regarding this vitamin. At the time when the survey was taken these products were not available and B_1 deficiency was both widespread and acute.

Vitamin C (ascorbic acid): The average daily vitamin C consumption was 33 mg. or 52 per cent of the standard. Only one family (3 per cent) had an adequate intake, four families (14 per cent) were inadequate and twenty-four families (83 per cent) were markedly deficient. This deficiency is also very acute and is on a par with the B_1 deficiency. If the survey had been made in the summer when fresh vegetables are cheap and easily obtained, instead of in February, this deficiency would not have been so acute. However fresh fruit, the other good source of vitamin C, is expensive at all times and seems beyond the reach of families with low purchasing power.

SUMMARY

In the twenty-nine families studied in this survey, the calories, protein, iron and vitamin A requirements were reasonably adequate in nearly every case. The calcium intake was not as high as it should have been, with 24 per cent of the families being markedly deficient. In the case of B_1 and C the situation was extremely serious, with over 80 per cent of the families having a markedly

deficient intake of these two factors. In comparison with the Council Surveys of 1939 the Winnipeg families showed the same widespread deficiency in B_1 and C, but presented a much better picture where all the other dietary factors were concerned. Undoubtedly these selected families in Winnipeg have made good use of the educational program of the Family Bureau. However, there still remains much to be done. The importance of milk if the calcium requirement is to be met, the use of whole cereals and Canada Approved bread and flour so that thiamin deficiency will disappear, and increased consumption of fresh fruits and vegetables to combat vitamin C deficiency must still be stressed if the diet is to be nutritionally adequate. Although the diet can be improved as a result of education, lack of it is not responsible for all dietary deficiencies. Insufficient income is the difficulty in many cases. Perhaps some form of subsidy is necessary in those families where the wage-earner has reached the peak of his earning power and still is unable to purchase the optimum quantity and quality of food for his family.

A National Health Program*

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ANOTHER voice could have addressed you with more authority on national health. Until now I have been particularly interested in and limited by my activities to municipal health problems. However, I am following with interest all health movements in this country and even outside Canada; this may be an excuse for presuming to talk on health problems of national concern.

Certain death rates, still too high, attributable to preventable causes, the high percentage of recruits (44 per cent) below army medical standards, malnutrition observed among our young people—all these demand a better co-ordinated plan of fighting disease. Various measures therefore are imperative to improve the health conditions of our people; we must not only face actual conditions, but what concerns you and me chiefly is the post-war period: the health of the generation which will follow ours. Because of the war, health problems are increasing in severity and incidence, and this condition will remain after the war.

Social and Health Problems

The first measure which is indicated in a national program is—and here I agree with all public health authorities—to intensify *public education* in matters of health. Public health is chiefly an educational problem: that is truer today than ever before. To teach health and the laws of health is the principal object and the prime purpose of any health department—whether it be federal, provincial or municipal. First, the various groups of our population must be educated if we wish to put into practice all the measures of public health which we advocate. To be truly effective, education must be carried out chiefly in the home.

Among the more important problems before us is that of *nutrition*, to which the federal authorities are paying very particular attention now and not without reason. This problem must be solved. Nutrition must be more particularly watched at this time when war conditions are forcing the adoption of rationing. The people must be given a well-balanced diet and at the same time it must be as economical as possible.

To this nutrition problem is linked that of *child health*. Infant hygiene, let us not forget, is a problem of child feeding and of education of mothers. Here well-baby clinics play a great part. Their influence has brought about, in this country, a great decrease in infant mortality and in deaths attributable to diarrhoea, which has become a secondary cause of death among infants, instead of the principal cause.

In general, in our large centres, and in the counties organized as health

**Presented at a meeting held by the Health League of Canada in Toronto on October 21, 1942.*

units in the provinces, the child, up to two years of age, seems to be well supervised, and this holds even up to three years of age. After that age, until he enters school, he is lost to health supervision for three or four years of relative neglect, and does not again come under supervision until the age of six or seven.

The pre-school age is one of the most dangerous and that which will have the greatest influence on the whole life of the child. It is the age during which he is most subject to communicable disease against which he should be protected. His general health, his teeth, his feeding, should all be the object of special care.

Greater and greater attention should also be paid to *pre-natal hygiene*. The survival and the continued good health of the Canadian mother and, I should add, the lowering of the infant death rate attributable to congenital causes during the first weeks of life, depend very largely upon the medical care which the mother has received. Pre-natal care, in the private doctor's office, at the hospital or in the health centres, is clearly becoming more and more necessary and it should be placed within the reach of all.

Side by side with the well-baby clinic, the pre-natal clinic and the pre-school clinic must be considered as national health measures.

In schools, all pupils should be the object of proper health supervision. This should be periodical and sufficiently continuous to follow the child from his first day at school until he finishes. The health supervision which the child received in primary school should be continued throughout his school life including high school.

In Montreal, we believe that we have a reasonably good child health service. (Recently we received a certificate of commendation in the Canadian City Health Conservation Contest held jointly by the American and Canadian Public Health Associations.) In spite of this, we found around 50 per cent of the children to be suffering from defects. Note well these figures: 50 per cent defective at 6 years, at the very start of the school career; 50 per cent as an average of all pupils, old and new, during the school year; and almost 50 per cent in their early twenties, when they were called to military service. Are not these figures striking?

As for me, I see a relation between these figures: firstly, because this proportion of defective children has remained about the same for the past fifteen years and, secondly, because experience shows us that a great proportion of children found defective remain so in spite of repeated advice to parents. Many, however, are treated and with advantage.

The periodic health examination of infants and children of pre-school age at the clinic, of the pupils, young or older, at the primary or secondary schools, was the first step towards the inauguration of the periodic health examination which is now provided by many industries, and which should become more and more general.

The health examination at regular periods assumes the greatest importance in the fight against disease. This health examination is an excellent weapon in the hands of the doctor to aid in the conservation of health. It helps to find unsuspected diseases such as tuberculosis. It allows hidden illness to be detected, when it has not as yet been brought to the attention of the person affected; such

a person thinks he is in good health and lives in complete security thinking that he is not suffering from any disease whatsoever but, imperceptibly, the malady does its work and soon the person is stricken.

The cooperation of the practising physician is necessary to put this into effect. Medicine is gradually veering towards preventive methods for the greater benefit of society. In former times, the private physician and the health officer seldom came together; now they are becoming more and more cooperative. The doctor, instead of considering his patient only as a sick person to be treated and cured, must watch over the health of the whole family.

There must be greater expansion of dental hygiene through the carrying out of a program of public education which will demonstrate the importance of *dental health* and of providing the necessary facilities for treatment.

The mental hygiene problem is a serious one. Mental hospitals are overcrowded. Mental hygiene must be developed in the schools.

It is the duty of the public health authorities to take advantage of every means within their reach to prevent the development and spread of *communicable diseases.*

Pasteur's discoveries and methods of vaccination and immunization against certain communicable diseases now allow us to control these up to a certain point. Vaccination against smallpox should be universal. Through proper legislation and education of the public we have completely eliminated this disease in the Province of Quebec. In Montreal, there has not been a single case of smallpox in the last twelve years and not a single death since 1918. Since 1928, more than 216,000 children have been immunized in the city of Montreal.

These protective measures should be made available everywhere in Canada for the benefit of the whole population. Special methods should be applied to reach recalcitrant cases. For example, a special effort made in Montreal has succeeded in raising the percentage of children who have been immunized from 65 per cent to 85.

Pasteurization of milk should be universal. Raw milk and its products still remain the cause of too many infections—tuberculosis, typhoid fever, and undulant fever, and for a considerable amount of infant mortality. The results obtained where pasteurization of milk has been enforced are proof of its value.

Tuberculosis is now showing an increase in Canada. A coordinated campaign for the early discovery of cases and contacts and for providing facilities for hospitalizing patients in sanatoria constitutes the essential elements of success in the anti-tuberculosis fight.

However, let me give you certain encouraging aspects of the fight against tuberculosis: improved educational standards in relation to this disease and the means of preventing it; more effective cooperation on the part of the doctors; and the accepted use of X-ray examination, now recognized as essential in earlier and more precise diagnosis.

Another problem which I must mention is that of *venereal disease*, a terrible affliction which appears to be widespread.

In Quebec we have adopted a provincial law requiring doctors to report cases and infectious patients to receive treatment. As this law has been in effect

for only a short time it is too soon to be able to judge its effectiveness or to draw conclusions, but this is certain: up to the present there has been an appreciable improvement in the discovery of cases and in the number who are under treatment. The free distribution of medicine to all doctors is facilitating treatment and lowering the cost to the patient. The creation of a social service, an essential element in this fight, permits supervision of the patient.

What may be said of the *problem of sanitary dwellings,* chiefly for the working class, now a most complicated problem because of war industries?

"Together with food and clothing, shelter is a fundamental need of human existence. No housing program can be sound unless the shelter it provides is healthful" has stated a Committee on the Health of Housing of the American Public Health Association. The thirty basic principles and specific requirements contained in the committee's report are believed to be fundamental minima for the promotion of physical, mental and social health, essential in low-rent as well as high-cost housing. They are based on the fundamental biological requirements of the human organism.

Although it is not the object of my address to stress the housing problem, may I, however, point out to you that Montreal, as well, I presume, as other important Canadian municipalities, is considering a post-war program of housing for low-wage earners. Our City Planning Department has taken due cognizance of the fact that the incidence of infant mortality and tuberculosis as well as the general death rate has shown a steady reduction in Montreal during the last twenty years. It has been found that the contrast in this respect between the higher and the lower rental areas remains very noticeable, and that better housing for the lower wage earners would contribute to a general improvement in health conditions and to the reduction of juvenile delinquency.

May I also stress the importance of industrial hygiene and of its development in provincial and municipal fields. Industrial hygiene and sanitation are an economic force in the life of the country. Labor legislation and improvement of working conditions are vital problems in which sanitary authorities should be interested. Their activities should contribute with those of the labor authorities, to improve the physical, intellectual and social status of the workers.

One of the reasons for the relatively low level of public health in Canada is certainly that there are altogether too many families with insufficient incomes. Improvement in living conditions is a social problem and all social problems are linked with public health. So long as there are hundreds of thousands of households where there is not sufficient income to pay for anything except the barest necessities of life, there will be misery and disease. We must—after the war, of necessity—revise our standards of living and raise wages and salaries in such a way as to ensure more income to hundreds of thousands of families. Otherwise all the measures which we might take will have only partial success. If thousands of Canadians live in unhealthful working conditions, if they dwell in unsanitary houses, if they have large families—and we will need large families and high birth rates—to whom they cannot give the required care, you cannot expect to improve public health in a general and effective manner. Moreover, if medical care, the services of doctors, dentists, and nurses, are not better dis-

tributed among the various sections of the country, all our efforts will go practically for nought.

FULL-TIME HEALTH SERVICES

In the application of the measures which I have mentioned—which must be national in scope, but which must be applied locally, in each province and municipality—it is important, if they are to have complete and effective results, that they be entrusted to official organizations, devoting their full time to this work and permanent in character, to a staff which will devote all its time, its initiative and its energies to its work and to the public interest. Such a body and staff will be responsible for coordinating all the measures adopted to carry out the program. The public health man is one whose duty it is to act as teacher and he must not be required to divide his efforts between his regular and outside duties.

Besides the organization of a central health department, in a province or in a large city, there is a general tendency, which is becoming more and more popular, to organize "county health units" in rural and small town districts, with a director and staff on a full-time basis, and, in cities, to decentralize the central office by forming "city health districts", which also have their full-time staff. This system of organization is in the course of being developed in several larger centres; the organization is in effect in Montreal. I had the opportunity, some few years ago, thanks to the kindness of Dr. Gordon P. Jackson, your Medical Officer of Health, of visiting your local health department and of securing much useful information towards carrying out our project in Montreal.

In this connection, the Province of Quebec, I think I can state without boasting, has taken the initiative. The establishment of county health units in rural districts has been one of its achievements. These units have done excellent work in centres which were not organized from the point of view of public health and the results obtained exceed all expectations.

Sixty-three rural counties of our province are served by fifty-one health units with full-time staff, including at least one doctor qualified in public health; public health nurses, and health inspectors who in most cases hold the "Certificate in Sanitary Inspection (Canada)" granted by the Canadian Public Health Association, and graduate veterinarians. A program drawn up according to the needs of the locality guides the work of the staff. Scientific experimental work and research are encouraged and the primary object of these health units is to educate the public.

Although the law stipulated that the Minister of Health can establish an unit where he considers it opportune to do so, we have never been obliged to use coercive measures. Indeed, we have hardly been able to fill the annual demands for new organizations. Municipalities tax themselves to secure the services of a unit.

With regard to *city health districts*, I would add a few suggestions.

The complex nature of municipal health administration in a large centre entails decentralization and the organization of city health districts.

At the time of the inauguration of a district in Baltimore, Dr. Huntingdon

Williams, Commissioner of Health of that city, said: "It would logically seem quite as necessary for a large city health department to decentralize its services in this manner as for a fire department or police department to have district stations in order to render more speedy and efficient neighborhood service."

This organization has a double objective: firstly, to give the population the most effective service by making it more accessible to all; secondly, to investigate local requirements. It also has the purpose of attracting the public's attention and of developing a civic spirit by training citizens to take more interest in matters of public health.

The great advantage of the city health district is that it brings health services closer to the people.

Our plan is to divide Montreal into eight health districts and already six of these have been organized. The population of each varies from 100,000 to 130,000. The direction of each is entrusted to a "district health officer", a doctor qualified in public health who devotes all his time to his duties and is assisted by a full-time staff.

It may be interesting to say, in passing, that we have on our staff in Montreal about twenty-five physicians, engineers and nurses to whom fellowships have been granted by our City and by the Rockefeller Foundation in American and Canadian Universities (the University of Toronto, Harvard, and Johns Hopkins) and a few others secured their Diplomas in Public Health from our local universities (McGill and the University of Montreal). A certain number of our nursing staff are qualified in public health nursing; the majority of our inspectors are graduate veterinarians or hold a certificate in sanitary inspection.

Suggestions

In concluding may I take the liberty of making the following suggestions:

1. As the first suggestion, and here I am in full agreement with a resolution adopted at the recent annual meeting of the Canadian Public Health Association held in June last in this city, I believe that the federal administrative authority should grant sufficiently generous appropriations to help the provinces and the municipalities to carry out a national public health program, the responsibility for which they should retain. This would make possible the organization throughout Canada of full-time local health services, rural county units or city health districts in order that adequate health supervision may be made available to all the people of Canada.

2. Organization of an intensive, continuous and persistent campaign of education in public health throughout the country.

3. Full support to the nutrition campaign undertaken by the federal authorities with whom provinces and cities are cooperating.

4. Compulsory pasteurization of milk in all provinces.

5. Intensification of the fight against maternal mortality by making prenatal care more accessible.

6. Organization of a home nursing service as part of maternal hygiene services.

7. Development of pre-school health services and of school health services in all primary and secondary schools and in high schools.

8. Promotion of periodic health examination for adults.

9. Protection of all Canadian children against smallpox and diphtheria.

10. Intensification of the fight against tuberculosis by providing facilities for early diagnosis including X-ray examination, and for treatment by the provision of necessary beds in sanatoria.

11. Provision of more hospitals for mental cases and development of mental hygiene facilities.

12. Development of the program of work against venereal disease, including legislation and compulsory treatment.

13. Provision of medical and dental treatment facilities, including an adequate plan of health insurance in conformity with our needs.

14. A national program of adequate housing for all groups of wage-earners.

The Influence of Physical Environment on the Public Health*

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LOOKING back over more than forty years of active public health work, the thing that stands out most clearly is the change in the administrative view regarding the contribution of the physical environment in the incidence of sickness. Nowadays it is the fashion to emphasize the importance of the individual—particularly the child—in health administration, especially in regard to communicable diseases. Great efforts are now made to render individuals immune to attack by these diseases, with, in some respects, very good results. But is there not a tendency to place so much emphasis on this aspect of health administration that the importance of the physical environment, as a contributory cause of sickness or poor physique, is being forgotten. While work is being done to cut down the incidence of communicable disease, vital statistics have an uncomfortable habit of showing—except, perhaps, as regards tuberculosis—how small a part these really play in the general life of the community. The comfort and well-being of the community are undoubtedly affected adversely by the prevalence of many minor ailments, some of which become serious; and to these the physical environment bears a definite relationship which, unfortunately, does not seem to be appreciated at its proper value by health authorities.

Formerly, perhaps, too little attention was paid to the individual regarding his potentialities as a carrier of communicable disease and the possibility of rendering him immune to such sickness. But all the other work done then was not necessarily wasted! For instance, when a case of diphtheria was reported, it was the practice in the past to have an immediate investigation made of the plumbing installation in the patient's home; whereas nowadays a search is made for carriers, contacts are temporarily immunized, and efforts are made to have the whole child population rendered immune to the disease. But was the investigation of the plumbing installation unnecessary? It is an astonishing fact that the coincidence of diphtheria and bad plumbing was very common indeed; and the inference is that this insanitary condition—and also, perhaps, a waterlogged site or a damp home—might have given rise to throat conditions and general poor health which allowed the diphtheria bacilli to gain a foothold. The newer practice is, of course, the result of the advance of knowledge; but is there not a tendency, as suggested before, to lean too much in the direction indicated—to assess the individual too high and the physical environment too low—in the job of tackling the eradication of such diseases?

After the abandonment of the idea that a sick person was possessed of a

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devil, the immediate physical environment of those who suffered from communicable disease received the blame, probably because similar conditions seemed generally to produce similar results. But with our wider knowledge we have now put this idea, also, into the background, for we have proof that communicable diseases are caused by definite agents, apparently in many cases irrespective of the physical environment; and we know, too, that certain specific toxoids and vaccines afford protection against certain diseases. The question arises, however, as to whether the immunity thus given is the *sum total* of all that is necessary. Is it not an ascertained fact that these diseases are more likely to occur in certain types of areas than in others; and does this practice take into account the many ailments which have not been proved to have any definite causitive agent? Is it not likely that insanitary suroundings, overcrowding, and unsatisfactory habits may lay the foundations for the occurrence of both communicable disease and other sickness? After all, throat infections are more likely to be found where the environment leads to poor nose and throat conditions. A sickly population is more susceptible to communicable disease than a healthy one. Only too many people spend most of their lives amid insanitary conditions—damp housing, overcrowding, insufficient sunlight, poorly ventilated homes, working places and amusement centres, and other unsatisfactory and unsightly surroundings. The experienced health official knows that most of his work is located in these places, not only to ameliorate the conditions, but also because of outbreaks of communicable disease there.

While the use of various vaccines and toxoids certainly gives most individuals some immunity from specific communicable diseases, are not the general conditions under which these diseases occur likely to underlie much other unrecorded illness, and do the vaccines afford protection against these other illnesses so arising? Take, as an example, the occurrence of one case of typhoid fever. This case was discovered in a camp housing about seventy men. The probable source of the disease was attributed to the use, for dishwashing, of unboiled, polluted water taken from an adjoining small lake. Inquiry showed that practically every person in the camp had been more or less sick with intestinal trouble during the short period before conditions were remedied, although none of the others contracted typhoid fever. Some of those affected by this sickness had been inocculated against typhoid fever. But the record here showed only one case of typhoid fever: while the combined time lost as a result of the other sickness was much greater than that caused by the typhoid case. Had the infection of typhoid fever not been present, this general sickness might have continued for some time and have resulted in a general loss of efficiency over the whole personnel. Some such condition existed in Cochrane prior to the introduction, into the town water supply, of the typhoid infection which caused so serious an epidemic. Without doubt such cases could be multiplied, if it were not for the fact that no records are made of the accompanying sickness unless a definite communicable disease is present. What, then, must be said of the effects on health of the insanitary conditions known to exist in so many places? These may not be such that definite danger to health can be proved under the Public Health Act. Nevertheless any health official of experience realizes their deleterious

effect on individuals: and he knows, too, that they do a very certain long-time harm to the general physical and mental health of the community.

Such unsavoury conditions may also have other effects which later on result in gradual deterioration of the environment. The evacuation of children from many of the large cities in England to country villages showed the harmful effects of bad environment. Quite a few of these children, placed for the first time in healthful surroundings, where every facility for cleanliness and healthy play was present, longed to return to the dreariness of their former homes, evidently preferring these insanitary conditions to the country air and sunlight. These cases point to the need for a more definite education of such children, so as to make them dissatisfied with the objectionable environment into which they have been born. But such education is not all: just as teaching school children the rules of personal hygiene is not an end in itself. The opportunity to put the precepts into practice is needed too. In a rural school which has no adequate sanitary facilities, little is to be gained by advising the pupils to wash hands before meals, etc., if the only provisions for this practice are a dirty wash-basin, a dirty common towel, and no soap, and if no arrangement is made for the proper disposal of the waste water. If such children, at the same time, live in overcrowded homes with no sanitary facilities worth the name, how can they be expected to profit from this education, when they cannot, without difficulty, practise it: and when they see no other person practising it? The reaction of parents to insanitary surroundings, overcrowding, etc., tends to an increasing general laxness in sanitary practices, as they find the fight against such conditions everlasting, and as these conditions gradually undermine their health. So it is only to be expected that such surroundings, both animate and inanimate, will eventually have the same effect on the children, despite any other influence. It is obviously an axiom in public health administration that every possible provision should be made to render cleanliness *easy*. We practise this precept in regard to dairies and places where foodstuffs are handled. Why should it not be done in all the homes, which are just as important? The provision of the most modern equipment in a restaurant is not considered all that can be done, however: the operator is expected to know how to use this equipment efficiently, and to put this knowledge into constant practice. In the same way the dairyman is expected to have cleanly habits, besides living up to the letter of the law in regard to his premises. So the provision of even the best of housing for the people is not all that can be done: education is needed, too, on how to make the most of the better environment.

Perhaps most vital in the physical environment of the people are their homes, working places and places of amusement; the latter two have been given some attention by health authorities and other law-enforcing bodies, but how much is generally known of housing conditions, particularly those of the poorer sections of the population, and what is being done to improve them? Have we any machinery available for ascertaining accurately what these conditions really are, so that the problem of adequately correcting them can be tackled? There is at present no definite minimum standard of housing set in Canada, so far as the writer knows: that is to say, a workable standard. Of course there is the condemnation of houses, under the Public Health Act, which are unfit for human

habitation. But there are hardly two corresponding opinions as to what is meant by the phrase "unfit for human habitation". Would it not be better to do as Great Britain did many years ago—establish a standard of fit housing for the whole country; and then set about ascertaining, thoroughly and constantly, the actual housing situation in relation to that standard? Then there would be records, which could be collected centrally, showing the extent of the problem and the size of the job ahead in the way of rectification. While this is being written, at the very moment when statistics are shouting aloud information regarding the deterioration of our young manhood, many are being housed in the vicinity of our munition plants under conditions which are going from bad to worse. Many of these new and enlarged plants have been designed to provide the best possible working atmosphere for employees. But only too many of these same employees are housed in overcrowded, insanitary places, thus offsetting the benefits to be expected from the excellent working conditions. Amongst the things hoped for in the provision of the best working equipment are the acceleration of production and the reduction of the accident rate. But it has been found that accidents are becoming more frequent: and may not the lack of proper housing, with its complements of discomfort and insufficient healthful rest, have a good deal to do with these disappointing results?

This question of housing is an urgent one. There should be adequate machinery for the selection of the sites of future communities, for seeing that they are properly planned and built over, that such beauty spots as are encompassed are not spoiled, and that our rivers and lakes are not unduly polluted. But the control of housing should not be confined to the populous places: probably more unsatisfactory homes, proportionate to the population, will be found in the scattered farm areas than in the towns. In the North we have case after case of tuberculosis in settlers' families, where, one would surmise, the disease would be uncommon owing to the healthful, open-air life to be led there. But an investigation into that environment would have to take into account the insanitary, often overcrowded and poorly lighted condition of the homes of these settlers, frequently the poorness of the diet, and the utter lack of ventilation, especially during the severe winter weather.

Here, then, is roughly the environment in which we expect to reap the benefits of the very latest discoveries of science. We find a considerable proportion of our population living under conditions which are very far removed from those which any health administration would predicate for the best vital statistics and for the general good health and comfort of the community. Many live in overcrowded and unsatisfactory dwellings, often located in areas which are themselves overcrowded and dreary. Others live in the open spaces, but exclude pure air and sunlight from their homes; and to many, if the wolf is not scratching at the door, he is never out of earshot. Apart from the effect of the nagging worry of ever-impending want, there is also the question of insufficient and improper diet. In such circumstances as these, how is it possible to get the best results, or even good results, from any system of health administration and education? Should not the work of improving the housing conditions of the people, and preventing the repetition of past mistakes in town planning and

housing, be given a very prominent place in the program of any health administration—as prominent, say, as schemes for immunizing against communicable disease; and for this purpose, should not there be an agitation to provide the tools wherewith to do the job of cleaning out the festering spots and replacing them with conditions such that sunlight and fresh air can help in the healing? If this is done in conjunction with education and training of all in the proper use of the equipment to health thus put in their grasp, and if the spectre of want is removed, there might be a definite hope of eradicating most of the communicable diseases and many of the bothersome, and ofttimes expensive, ailments to which so many are subject;—so that, for all, there might be a brighter, healthier and happier life.

Hold It

THE public health "front" is in a position analogous to that front at present being defended by our Russian allies.

At some points our public health workers are being pushed back from that "line" attained before the present war. Ground has been lost in some sectors by the overwhelming force of circumstances. Depleted personnel and funds, new problems created by war-time conditions, and wider activities demanded by our war effort itself have compelled us to weaken our defences at some points.

It is a time which calls for generalship on the part of the health authority. He must survey his present position and decide what salient points in his program are important enough to hold to the last ditch; those points where he will be willing to concentrate the greater portion of his resources if necessary. For many of us, sooner or later, are likely to find it impossible to maintain our health program in all its detail.

Even as war itself, however, this misfortune may bear useful fruit. Many health workers have suggested in recent years that certain of our customary public health procedures might bear re-assessment as to value. There are few, if any, health departments but who carry on some routine procedures because of custom or outdated regulations which have exceedingly little bearing upon the public health. Perhaps a forced house-cleaning may get our feet out of this mud.

However, the tenacity with which we are able to maintain the more essential of our health efforts for the duration will determine, to a considerable extent, our ability to seize that great opportunity of advancement in public health which will present itself when peace returns.—*G. M. Little, "The Alberta Health Worker", October 1, 1942.*

A Tuberculosis Fact-Finding Study in the London Secondary Schools*

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A PROGRAM for an intensive community campaign against tuberculosis should include surveys of special groups of persons in susceptible age periods as well as the study of individual cases and contacts. Where such surveys have been carried out, among school children, high school and university students, nurses, industrial workers, etc., they have usually included the use of the tuberculin test with chest X-rays of the positive reactors, physical examinations and laboratory investigations where indicated. Methods of procedure have probably been as varied as the number of groups studied but the objective in every instance has been the detection of the early or suspicious case in the non-infectious and asymptomatic stage. This, of course, is the foundation of tuberculosis control, and as such becomes an important part of a community public health program.

The value of a tuberculosis survey of a special group depends largely upon the completeness of the study, the accuracy of technique, and the uniformity and reliability of interpretation. Before commencing such a survey, it is important that careful consideration be given to the personnel and facilities available and how they can be most effectively co-ordinated. Careful planning and adequate preparation will mean much to the success of the program and the ease with which it can be carried through.

The purpose of this paper is to present a method of approach to such a group study, carried out among secondary-school students in London, rather than to relate any unusual findings or throw any new light on the significance of the tuberculin test as a diagnostic aid in tuberculosis control.

London, a city of approximately 78,000 population, has four secondary schools, with an enrolment for the year 1941-2 of 3,349 students ranging from 12 to 20 years of age. The survey was conducted as a joint program by the Health Services of the Board of Education, the City Health Department, the medical staff of Queen Alexandra Sanatorium and the local radiologists.

Preliminary to the survey, a broad educational program was carried out. A special talk was given and the sound film "Behind the Shadows" shown to the student body in every school. Similar talks were given to the Home and School Clubs throughout the city in an effort to reach as many parents as possible. Informative letters and explanatory pamphlets prepared by the Canadian Tuberculosis Association were distributed to students and parents. The teachers of health education in the schools placed special emphasis on the subject of tuberculosis and made use of a series of charts prepared by the

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Canadian Tuberculosis Association in their classroom instruction. It was felt that the educational work played an important part in gaining the co-operation of the parents and students for the tuberculin testing and X-rays.

The tuberculin test was offered free of charge to all secondary school students. The parent's request was required before a student could have the test. It was asked that every request card by returned to the school within a limited time, and an explanatory note be given where permission for the test was not granted. This facilitated greatly the follow-up work of students who failed to have the test.

By having the whole-hearted assistance and cooperation of the school principals and teaching staffs, difficulties of administration, organization and loss of time in carrying out the program are easily overcome. Considerable clerical work is required throughout the survey and the school office staff can be most helpful in this respect.

Tuberculin-testing clinics were set up in each school. The medical staff of Queen Alexandra Sanatorium did the tuberculin tests using Old Tuberculin 1:2,000 (1/20 mgm. tuberculin in 0.1 cc.) provided by the Connaught Laboratories through the Division of Tuberculosis Control of the Department of Health for Ontario. Nursing assistance was provided by the school, and public health nursing staffs. The tests were read by the Sanatorium doctors after forty-eight hours. In this way such errors as may result from faulty technique were reduced to a minimum and a uniform and experienced interpretation of the test was assured. Any redness, other than that from trauma, or infiltration about the site of injection, was regarded as a positive reaction. Doubtful reactions were interpreted as positive and no retesting was carried out.

Two thousand eight hundred and ninety-seven students were tested and read in May 1941. This represented 93.2 per cent of the total enrolment at the time. Two hundred and nine students did not have the test or were not present at the time of reading. One hundred and forty-eight of these had had the request cards signed but were absent either on the day the test was given or on the day for reading. Many of these had left school to take summer employment. Nine students were reported as having had a tuberculin test recently and were under supervision. Nine students were under the care of the family physician and would have the test done privately if their doctors advised it. Two students were advised by their family physician not to have the test. There were only 43 refusals for whom a satisfactory explanation was not given.

In February 1942 1,089 more students were tested and read, making a total of 3,986 tests done and read since May 1941. At the present time, 3,117 or 93 per cent of the 3,349 students enrolled in the London secondary schools have been tested and read.

In the 1941 survey of 2,897 students, 522 or 18 per cent showed a positive reaction to the tuberculin test ranging from 14.7 per cent in one school to 20.2 per cent in another. Students from all years were included in this survey.

In the 1942 survey of 1,089 students, 135 or 12.4 per cent showed a positive

reaction (8, 9, 11.6 and 15.6 per cent in the respective schools). The majority of these students were from the first year, having entered high school in September 1941.

Six hundred and fifty-seven or 16.5 per cent of the total of 3,986 students tested, showed a positive reaction to the tuberculin test.

The incidence of positive reactors according to age groups for the 3,986 students tested ranged from 10.3 per cent at age 12 years to 22.6 per cent at age 19 years. There was a continual rise throughout the teen-age period, the most marked increases occurring at ages 13, 16, and 19 years (Table I). The chance for casual infection of course increases with the

TABLE I

TUBERCULIN TESTING OF SECONDARY SCHOOL STUDENTS ACCORDING TO AGE
LONDON, ONTARIO, 1941 AND 1942

Age	*Number tested and read*	*Negative*	*Positive*	*Percentage positive*
12 years.....	29	26	3	10.3
13 "	548	473	75	13.7
14 "	881	753	128	14.5
15 "	952	805	147	15.4
16 "	680	552	128	18.8
17 "	465	378	87	18.7
18 "	267	215	52	19.5
19 "	106	82	24	22.6
20 and over.....	58	45	13	22.4
Totals.....	3,986	3,329	657	16.5

broader contacts made by the older age groups. The fact that the percentage of positive reactors increased more than 100 per cent from the age at which a child enters high school to that of early adult life, would seem to indicate that high-school children are still coming in contact with infectious tuberculosis somewhere in their activities. However, this is not necessarily the case, as many of the older students tested may have received their primary infection ten or fifteen years ago. To answer this would necessitate retesting the negative reactors of the first year before they leave high school. Such a program has been proposed for future tuberculin testing in the London secondary schools.

Through the cooperation of the local radiologists and general hospitals provision was made for chest X-rays of the positive reactors at a nominal fee. The charge for the X-ray was paid by the individual student. If he could not afford it, the X-ray examination was made at the hospital and paid for by the municipality. Only a very few did not pay for their own X-rays.

All the local radiologists and hospitals cooperated in this part of the program and the students were given their choice of radiologists. Students were sent in groups to the radiologist's office at a time convenient to the radiologist. Payment for the X-rays was handled through the school office. An interpretation of the film by the radiologist was not required. The X-ray films were later collected and interpreted by the staff of Queen Alexandra Sanatorium. In this way a uniform interpretation of all films was secured.

Written reports were mailed to the parents. No attempt was made to classify the interpretation of the X-ray films other than to note the presence of active tuberculosis, suspicious shadows, or cases in which further investigation or follow-up was indicated. The parents of students for whom further follow-up was recommended were interviewed by the School Medical Officer and referred either to the family physician or the tuberculosis clinic with a report of the X-ray findings and recommendations.

Five hundred and twelve or 78 per cent of the 657 positive reactors to the tuberculin test had an X-ray film of the chest. A number of students had left school in the meantime. The names of those who did not have an X-ray film were given to the Public Health Tuberculosis Service for investigation and follow-up. Many of these have since had an X-ray taken.

No case of active pulmonary tuberculosis was detected from the study of these films. Eleven students showed X-ray findings which warranted further investigation or follow-up. A record of these students is being kept by the School Health Service for future supervision.

Intensive group studies and broad educational programs are essential community health activities in the control and eradication of tuberculosis.

Observations on Cholera Vaccine*

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THE possibility that cholera vaccine might be needed for Canadian troops, and even civilians, was considered by Connaught Laboratories early in the war, and steps were taken to meet such a contingency. Cultures of *V. cholerae* were obtained from Manila, Hong Kong and Calcutta, and a method of preparing and standardizing cholera vaccine in bulk from suitable selected strains was worked out. Some of the problems encountered, and observations made, in the course of carrying out this assignment seem of sufficient interest to warrant reporting.

MAINTENANCE OF STOCK CULTURES

At the outset, a satisfactory method of maintaining stock cultures was sought. The effects of drying and freezing upon the viability of *V. cholerae* were studied in some detail, using a typical, smooth Ogawa-type strain from Calcutta for most of the experiments.

(*a*) *By Desiccation from the Frozen State*

The selected strain was grown at 37° C. in a nutrient broth medium of initial pH 8.3 for 16 hours. After thorough mixing with a mechanical shaker, 0.05 cc. amounts of the homogeneous suspension were transferred into 2 cc. vials. Immediate counts were made by the poured plate method on the contents of three vials, nutrient broth being used as diluent. The average viable population was 5.56×10^8 vibrios per cc., the lowest count being 88.5 per cent of the highest. The contents of several vials were frozen by means of a sodium chloride and ice freezing mixture at –20° C. Counts made upon the contents of three vials allowed to thaw at room temperature revealed that 99.69 per cent of the vibrios had failed to survive freezing and thawing.

Some vials were transferred from the freezing mixture, along with other vials which had not been placed in the mixture, to a desiccator over fresh anhydrous calcium chloride. A vacuum was drawn with a Hyvac pump and maintained for 24 hours. Counts on the contents of three "frozen-dried" vials and of three "dried" vials showed that no vibrios in the former survived, while in the latter, 99.98 per cent of the vibrios were apparently dead at the end of 24 hours, and none were found alive at the end of one week. Obviously freezing and drying over $CaCl_2$ with nutrient broth as a menstruum was not a suitable method for preservation of stock cultures. Although *V. cholerae* thrive on some very limited diets, physical changes tolerated by more fastidious micro-organisms were incompatible with survival of the vibrios.

*Presented at the eleventh annual Christmas meeting of the Laboratory Section, Canadian Public Health Association, held in Toronto, December 17 and 18, 1942.

The possibility was then investigated that certain particulate agents in suspension might to some extent protect the vibrios from the adverse effects of freezing, drying, or both. Fuller's earth, activated charcoal, finely ground and washed sawdust pulp, 5 per cent beef extract solution with or without Fuller's earth, failed to protect the vibrios during freezing and drying. Calcium carbonate gave some protection during freezing, so that 23 per cent of the vibrios could be revived; but drying *in vacuo*, in the presence of calcium carbonate, with or without freezing, left no viable vibrios in 24 hours.

On the other hand, vibrios remained viable for at least two months when suspended in either non-immune or inactivated immune rabbit serum, and dried from the frozen state over phosphorus pentoxide; but the resulting adherent mass did not permit satisfactory quantitative estimations of survival. More recently, adapting a method used by Griffitts (1), we have employed skimmed milk as the protecting agent, with satisfactory qualitative results. About 2 cc. of milk is used to wash a 6-hour growth of vibrios from three or four nutrient agar slants, seeded from an agar culture. About 0.2 cc. of this thick suspension is placed in each of several Pyrex constricted ampoules and frozen in a sodium chloride and ice mixture. The ampoules are placed in a desiccator according to the technique of Swift (2), but with KOH instead of P_2O_5 as the drying agent, being removed in 24 hours, when their contents are sealed under vacuum. Under these conditions, the dried milk forms a firm plug which goes readily into suspension when broth is added.

(*b*) *In Semi-solid Nutrient Agar*

For convenient preservation of cultures frequently employed, tubes of medium comprising 0.3 per cent agar in 1 per cent proteose-peptone water at pH 8.3 have been found satisfactory. After seeding, the culture is incubated at 37° C. for 24 hours. The vibrios grow abundantly on the surface, but can be dispersed throughout the medium by agitating the tube. The culture is then sealed with parafilm, and stored in the dark at room temperature, under which conditions there is no significant reduction in population in a week. However, if placed in the refrigerator at 5° C., the mortality rate may be high. For example, in one instance, during the first 48-hour period of refrigeration there was no appreciable decrease in the viable vibrio population; but by the fifth day only 10 per cent were living, while only 2 per cent survived to the seventh day.

SELECTION OF STRAINS AND PREPARATION OF POOLED VACCINE

In the selection of strains for vaccine production, we followed at first the criteria for true *V. cholerae* laid down by Mackie (3) and by Linton (4), the only other consideration being the presumed desirability of choosing strains from different localities. On these bases, two strains were selected from Manila, Hong Kong and Calcutta, and a pooled vaccine prepared from the six strains in the following manner.

Each strain was seeded upon a proteose-peptone agar plate at pH 8.3, and

incubated overnight at 37° C. Suspensions of the resulting growth were made in proteose-peptone water, and Roux flasks containing freshly-poured proteose-peptone agar at pH 8.3 were inoculated with 2 cc. amounts of each suspension. After incubation at 37° C. for 24 hours, the growth was washed from the flasks with about 4 cc. of 0.75 per cent phenol in physiological saline, which when diluted by the water of condensation present on the medium, gave a final concentration of about 0.5 per cent phenol, whereby the vibrios were rapidly killed. The suspensions were pooled and diluted to a concentration of 8,000 million vibrios per cc. (the turbidity lying between Nos. 4 and 5 on a freshly-prepared McFarland standard) with 0.5 per cent phenolized saline.

AGGLUTININ RESPONSE OF RABBITS TO VARIOUS TYPES OF CHOLERA VACCINE

The decision to use phenol as the killing agent was based upon a series of experiments designed to determine the agglutinin response in rabbits to three types of vaccine, heat-killed, phenol-killed, and formalin-killed. We looked to the development of circulating agglutinins in rabbits as a possible *in vitro* means of assay, since at the outset of this work, we were unable to find reference in the literature to any satisfactory animal test for the antigenic potency of cholera vaccine. Further, despite the unreliability of agglutinogenic capacity as an indication of the protective value of any bacterial vaccine, the development of agglutinins in laboratory animals injected with such a vaccine furnishes quantitatively tangible evidence that at least some component of the total bacterial antigens has survived the vicissitudes of the vaccine manufacture. Moreover, we were particularly anxious to verify the agglutinogenic capacity of the vaccines for rabbits, since subcutaneous administration of rather large doses to several human subjects had failed to evoke more than trivial and transitory agglutinin responses, a finding which conforms with most previous reports on this point.

Accordingly, a selected strain of *V. cholerae* was grown overnight on proteose-peptone agar and harvested with physiological saline. The suspension was adjusted to contain 10,000 million vibrios per cc., which were killed by heating in a water bath at 52° C. for 30 minutes. The same procedure was followed in the preparation of the phenol-killed and formalin-killed vaccine, except that the harvesting and diluting were done with 0.5 per cent phenolized saline and 1 per cent formalinized saline respectively, while the heating was omitted. The formalinized suspension was centrifuged down, and resuspended in physiological saline, to avoid the deleterious effects of massive injections of formalin.

Three separate groups of four rabbits were inoculated intravenously, each group with one of the three types of vaccine under test, the dosage being three 1 cc. injections, given at intervals of three weeks. The rabbits were bled one week after the second dose, one week after the third dose, and again five weeks after the third dose. The agglutinin titre of each serum was determined against six separate antigens, comprising three "OH" antigens, prepared by suitable dilutions from the heat-killed, phenol-killed, and formalin-

killed suspensions described above; and three "O" antigens. The "O" antigens were prepared by heating a suspension of vibrios in physiological saline in a boiling water bath for 15 minutes, thus killing the vibrios and destroying their "H" antigens. One portion of this suspension received no further treatment, and was designated "Heated O antigen". Other portions, treated with sufficient phenol and formalin to give final concentrations of 0.5 per cent phenolized saline, and 1 per cent formalinized saline, were designated "Phenolized O antigen" and "Formalinized O antigen" respectively.

The "OH" agglutinin readings were made after exposure of the serum-antigen mixtures to 50° C. for 4 hours, and to room temperature for a further 24 hours. The "O" agglutinin readings were made after 24 hours at 50° C. and an additional 24 hours at room temperature. The end-point was taken as the highest dilution of serum causing a distinct trace of macroscopic agglutination, following the usage of Gardner and Venkatraman (5). It should be mentioned that in titrating cholera "O", and to a lesser extent, "OH" agglutinins, the end-points are not as clear-cut as those obtained, for example, in the titration of typhoid agglutinins. All titrations demonstrated partial inhibition of agglutination in the first two or three tubes, then an intermediate zone of 4-plus agglutination, with a gradual scaling off in the higher dilutions.

Table I summarizes the agglutinin response of rabbits to the three types of cholera vaccine. The figures represent, to the nearest round number, the average of the agglutinin titres of the sera of four rabbits, as determined against each of the six antigens used. The validity of expressing the findings in terms of an average will be demonstrated later. The figures given in Columns 1 (representing average titres one week after the second dose of

TABLE I

COMPARISON OF AGGLUTININ RESPONSE IN RABBITS TO THREE TYPES OF CHOLERA VACCINE

Antigen	*Average Agglutinin Titres*								
	Heat-killed Vaccine			*Phenol-killed Vaccine*			*Formalin-killed Vaccine*		
	1	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*
"O" (Heated only)	60	70	100	220	250	190	280	310	70
"O" (Phenolized)	100	110	20	440	220	90	110	220	40
"O" (Formalinized)	Int.	Int.	Int.	Int.	Int.	Int.	Int.	Int.	Int.
Highest average "O" Titre.....	100	110	100	440	250	190	280	310	70
"OH" (Heated)	4,000	5,000	590	N.D.	8,000	1,170	N.D.	5,500	280
"OH" (Phenolized)	N.D.	6,000	530	5,000	11,000	1,170	N.D.	9,500	470
"OH" (Formalinized)	N.D.	5,000	530	N.D.	11,000	1,170	3,000	6,000	380
Highest average "OH" Titre.....	4,000	6,000	590	5,000	11,000	1,170	3,000	9,500	470

Note: Figures represent, to the nearest round number, the average agglutinin titres of the sera of four rabbits.
"Int." indicates interference of formalin with the "O"-antigen-antibody reaction.
"N.D." indicates titrations not done.
Columns 1, 2 and 3 show titres one week after the second dose, one week after the third dose, and five weeks after the third dose, respectively.

vaccine) indicate that the best "O" and "OH" agglutinin responses resulted from the two doses of phenol-killed vaccine. The third dose of each vaccine caused little elevation in the "O" titres (Columns 2), whereas the "OH" titres showed a definite tendency to rise. Five weeks after the third dose (Columns 3) the "O" and "OH" agglutinin titres had dropped in all cases from the levels shown on the preceding occasion; but the rabbits inoculated with phenol-killed vaccine maintained their titres to a higher degree than the others. Thus, under the conditions described, phenol-killed vaccine provoked higher initial "O" and "OH" agglutinin responses, which were better maintained, than did either the heat-killed or formalin-killed vaccines. On the basis of these findings, phenol-killed vaccine was used in subsequent animal experimentation, and was recommended for human immunization purposes.

Table I indicates that the presence of 1 per cent of formalin interferes with the agglutinability of a *V. cholerae* suspension. This concentration of formalin is only one-half that which interferes with the "O" antigen-antibody reaction among the Salmonellas, an effect which Topley and Wilson (6) suggest is due to the formalin so fixing the flagella over the bacterial surface that the somatic antigens are no longer exposed to the action of the "O" agglutinins. The monotrichous nature of *V. cholerae* would seem to preclude the possibility that formalin fixes the flagellum over the bacterial surface. An alternative assumption would be that formalin directly inactivates the "O" agglutinin-receptors without interfering with the "O" agglutinogenic capacity of *V. cholerae*. There is also the hypothesis that the "H" antigen extends over the greater part or perhaps the whole surface of the vibrio (which would explain the relatively high titres of "H" agglutinin obtainable) and that the action of formalin on this envelope of "H" antigen is such as to prevent the underlying "O" antigen from combining with the "O" agglutinin. Supporting this possibility is the fact that Linton, Mitra and Seal (7) noted such marked changes in the chemical constitution of vibrios during destruction of the "H" antigen as to suggest that this antigen was not confined to the flagellum.

Further reference to Table I shows that apart from the foregoing peculiarity of the formalinized antigen, the type of antigen used has considerable effect upon the agglutination titres shown by a given serum. Although these variations were reproducible, and were not due to faulty technique, no one antigen gave consistently higher titres; but the phenolized antigen showed a somewhat greater sensitivity.

The validity of averaging the agglutinin titres shown among the various groups of rabbits used in these experiments is illustrated by Table II, in which are set forth the agglutinin titres of the sera of four rabbits one week after the third dose of phenol-killed vaccine, when set up against the six antigens already described. In no instance was there more than two tubes' difference between the end-points given by the four rabbit sera when titrated in doubling dilution series against any one antigen.

VARIABILITY OF AGGLUTININ RESPONSE IN RABBITS TO DIFFERENT LOTS OF PHENOL-KILLED VACCINE

Each large lot of phenol-killed vaccine prepared for distribution has been

TABLE II

AGGLUTININ TITRES OF SERA OF FOUR RABBITS ONE WEEK AFTER THIRD DOSE OF PHENOL-KILLED VACCINE

Antigen		*Serum of Rabbit*				*Average Agglutinin Titre*
		A	*B*	*C*	D	
"O"	(Heated only)	250	125	125	500	250
	(Phenolized)	250	125	250	250	220
	(Formalinized)	Int.	Int.	Int.	Int.	Int.
"OH"	(Heated)	16,000	4,000	8,000	4,000	8,000
	(Phenolized)	16,000	8,000	16,000	4,000	11,000
	(Formalinized)	16,000	8,000	4,000	16,000	11,000

Figures represent the greatest dilution of serum causing a distinct trace of agglutination on macroscopic inspection.
"Int." indicates interference of formalin with "O"-antigen/antibody reaction.

tested for the production of agglutinins in rabbits. Table III presents the average agglutinin responses shown by groups of three rabbits to each of five separate lots of cholera vaccine. The rabbits received 0.5 cc. and 1 cc. of vaccine intravenously, with one week's interval between doses, and their agglutinin responses were determined one week after the second dose. Freshly-prepared, phenolized "O" and "OH" antigens, made from the same strain used in previous experiments, were employed. Although the vaccines were all produced by the same method, they evidently varied considerably in "O" and "OH" agglutinogenic capacity. The "O" and "OH" agglutinogenic capacities of the series of vaccines varied somewhat, but only over a comparatively narrow range such as might be expected from their uniform method of production. Minimum "O" and "OH" titres of 1:100 and 1:1,000 respectively, under the above-defined conditions, would seem a fair agglutinogenic standard for cholera vaccine.

TABLE III

COMPARISON OF AGGLUTININ RESPONSE IN RABBITS TO TWO DOSES OF DIFFERENT LOTS OF PHENOL-KILLED CHOLERA VACCINE

Antigen	*Average Agglutinin Titres*				
	Lot				
	I	*II*	*III*	*IV*	*V*
"O"	120	210	250	500	220
"OH"	1,170	1,330	2,000	1,330	2,000

AGGLUTININ RESPONSE OF RABBITS TO MIXED CHOLERA VACCINE AND T.A.B.T.

In order to determine the effect upon the agglutinin response in rabbits of incorporating cholera vaccine with T.A.B.T., two mixed vaccines were prepared by adding suspensions of phenol-killed and of heat-killed *V. cholerae*

respectively to T.A.B.T. Each mixture finally contained 4,000 million *V. cholerae*, 700 million *S. typhi*, and 225 million each of *S. paratyphi* A and B per cc. of tetanus toxoid. As a control, the standard T.A.B.T. was diluted with physiological saline to contain the foregoing numbers of typhoid and paratyphoid bacilli. Separate groups of three rabbits were injected with the two mixed vaccines, each rabbit receiving 0.5 cc. and 1 cc. intravenously, with one week's interval between doses. A control rabbit received similar doses of the diluted T.A.B.T.

Table IV shows the average agglutinin response of the rabbits to cholera and typhoid "O" and "OH" antigens one week after their final injections. The presence of cholera vaccine apparently does not interfere with the agglutinin response to the typhoid "O" and "OH" antigens in T.A.B.T. Further, although the density of *V. cholerae* suspension in the mixtures was only one-half that used in previous experiments, the response to the cholera "O"

TABLE IV

COMPARISON OF AGGLUTININ RESPONSE IN RABBITS TO TWO DOSES OF MIXED T.A.B.T. AND CHOLERA VACCINE

Antigen	*Average Agglutinin Titres*		
	Phenol-killed Cholera Vaccine in T.A.B.T.	*Heat-killed Cholera Vaccine in T.A.B.T.*	*T.A.B.T. alone*
Cholera "O"	170	100	0
Cholera "OH"	830	410	0
Typhoid "O"	830	830	500
Typhoid "OH"	4,000	2,000	2,000

antigens was nearly as great as the average of those shown in Table III. The "OH" response was, however, considerably less. The phenol-killed cholera vibrios again evoked a higher average agglutinin titre than did the heat-killed. The superior agglutinogenic capacity of the typhoid, as compared with the cholera antigens, is apparent.

AGGLUTININ RESPONSE OF RABBITS TO INTRAVENOUS AND SUBCUTANEOUS INJECTIONS OF CHOLERA VACCINE

Table I indicated that the third dose of cholera vaccine afforded little additional stimulus to "O" agglutinin production. To investigate this point further, and to reveal possible differences in response to the intravenous and subcutaneous routes of administration of the vaccine, four groups of three rabbits each were injected as follows at weekly intervals with a pooled vaccine containing 8,000 million phenol-killed *V. cholerae* per cc.:

Group 1—Two intravenous doses of 0.5 cc. and 1 cc.
Group 2—Two subcutaneous doses of 0.5 cc. and 1 cc.
Group 3—Three intravenous doses of 0.5 cc., 1 cc., and 1 cc.
Group 4—Three subcutaneous doses of 0.5 cc., 1 cc., and 1 cc.

Table V presents a comparison of the average agglutinin responses of the three rabbits in each group, one week, four weeks and eight weeks after the final dose when tested against phenolized "O" and "OH" antigens.

The titres following two doses of vaccine suggest that there is little to choose between the subcutaneous and intravenous routes. The "O" agglutinin titres were practically identical one week after the final injection, and reached the same low level by the eighth week. The "OH" agglutinin response to intravenous injection was superior, persisting at a high level for four weeks, but rapidly dropping during the subsequent month to a point little above that shown by the rabbits receiving two subcutaneous injections.

TABLE V

COMPARISON OF AGGLUTININ RESPONSE IN RABBITS TO TWO AND THREE DOSES OF PHENOL-KILLED CHOLERA VACCINE ADMINISTERED BY INTRAVENOUS AND SUBCUTANEOUS ROUTES

Antigen	*Average Agglutinin Titres*											
	Two Intravenous Doses			*Two Subcutaneous Doses*			*Three Intravenous Doses*			*Three Subcutaneous Doses*		
	1	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*
"O"	120	90	20	110	50	20	400	100	20	50	20	10
"OH"	1,170	2,000	30	830	290	20	5,330	1,500	30	580	190	0

Figures represent, to the nearest round number, the average agglutinin titre of the sera of three rabbits.

Columns 1, 2, and 3 show titres one week after final dose, four weeks after final dose. and eight weeks after final dose, respectively.

The rabbits receiving three intravenous doses produced considerably higher "O" and "OH" titres than did those receiving only two intravenous doses; and also did far better than did the rabbits receiving three doses subcutaneously. However, the agglutinins in the 3-intravenous-dose group no longer persisted at a higher level even by the fourth week after the final dose. The poor response of the rabbits receiving three subcutaneous doses was surprising, and at present cannot be satisfactorily explained. In all groups, a rapid fall in the agglutinin titres from their highest levels was noted, conforming to the reports of various workers that circulating agglutinins disappear early in recovered human cases, and in vaccinated humans and laboratory animals.

The results of this experiment, taken in conjunction with those in Table I, suggest that the agglutinogenic capacity of cholera vaccine for rabbits is best determined one week after the last of a series of two or three intravenous injections, given at weekly intervals. The effect of lengthening the time interval between doses given both intravenously and subcutaneously is under investigation.

MOUSE LETHAL TESTS WITH *V. cholerae*

Bearing in mind the fallacy of assuming that the agglutinogenic capacity of cholera vaccine for rabbits was any criterion of ability to confer immunity,

an animal protection test was sought. Guinea-pigs are well known to succumb to appropriate dosages of virulent *V. cholerae*, while Metalinkow and Gaschen (8) have reported the caterpillar Galleria to be very susceptible; but owing to a meagre guinea-pig supply, and a complete dearth of Galleria, attention was directed towards the possibility that the mouse might furnish a test for both virulence and antigenicity of strains of *V. cholerae*.

Minimal Lethal Dose for Mice

Each of the strains originally selected for vaccine production was seeded into tubes of proteose-peptone water containing 1 per cent glucose at pH 8.3, and were incubated at 37° C. for 6 hours. The addition of 1 per cent glucose to the medium ensures a uniform growth throughout, and eliminates the tendency of many strains of *V. cholerae* to form surface pellicles. Appropriately spaced amounts of the homogeneous suspensions were injected intraperitoneally into mice. The minimal lethal dose of 5 strains was thus found to range from 0.4 cc. to 0.6 cc., while the sixth strain had an m.l.d. of greater than 0.8 cc. This strain was therefore replaced, for vaccine production purposes, by another strain having an m.l.d. of 0.5 cc.

Pathological Findings in Mice Killed with V. Cholerae

Mice that succumbed to an intraperitoneal injection of *V. cholerae* had fairly characteristic pathological signs. Within half an hour of the injection they hunched together in their cages, inactive and obviously ill. Death usually occurred within 16 to 24 hours, but where the dosage was barely lethal they often survived until the second or third day. Autopsy findings revealed injected vessels in the skin and in the mesentery. Invariably the upper nine inches of the small bowel, or slightly over half its length, was filled with a pale, greenish-brown viscous fluid, having a soft, jelly-like consistency. In mice dying more than 48 hours after the injection, this fluid was dark green in colour. The liver, spleen, lungs, kidneys, brain and heart showed no typical features. Dark fluid blood was always found in the heart, whether death had occurred a few minutes or some hours before the autopsy was performed.

Cultures taken at autopsy of more than two-score mice were positive for *V. cholerae* in the following percentages:

Peritoneal cavity	100
Heart blood	100
Upper intestinal contents	88
Stomach contents	21
Anal contents	never positive

It is possible, as was suggested by Sanarelli (9) regarding the pathogenesis of cholera in the guinea-pig, that the intestinal infection in mice following intraperitoneal injection of *V. cholerae* plays a part, along with the septicaemia, in the lethal effect of the micro-organism. The alkaline zone of the small intestine is an ideal environment for rapid growth, and hence rapid disinte-

gration of the vibrio, with resulting absorption of endotoxic products from the intestine.

The finding of the vibrios in only 88 per cent of the upper intestines does not necessarily give a complete picture of the situation there, as all of those specimens reported negative were overgrown by "spreader" types.

Preliminary Mouse Protection Experiments

Having determined the m.l.d.'s of the various strains used in vaccine production, 18 mice were injected with two intraperitoneal doses (0.2 cc. and 0.5 cc.) of pooled cholera vaccine with one week's interval between doses. Three weeks after the final dose, the mice were divided into six groups of three, each group being challenged with 1 cc. of a different live culture of the strains of *V. cholerae* used in the vaccine manufacture. This dose represented about 600 million *V. cholerae*, or about 2 m.l.d.'s. Two normal mice were used as controls for each strain, and received 0.6 cc. of live culture. Of the 18 vaccinated mice, 17 died—16 of them within 24 hours. Of the 12 control mice, 8 died; but only one died within 24 hours. In other words, instead of being protected against intraperitoneal injections of living *V. cholerae*, the vaccinated mice became sick sooner and died more quickly when given a challenge dose than did control mice. A possible explanation would seem to be that the vaccinated mice may have developed bacteriolysins, which caused accelerated lysis of the large number of vibrios introduced in the challenge dose, so that death occurred from acute toxaemia.

Mouse Lethal Test with Mucinized Vibrio Suspensions

At this point in our work, Griffitts' (10) paper appeared, describing a mouse-mucin lethal test. This test has proved satisfactory in the selection of highly virulent strains of *V. cholerae* for vaccine production, as well as in the assay of the mouse-protecting efficacy of cholera vaccine. Incidentally, as long ago as 1919 Cantacuzene and Marie (11) were successful in rendering an otherwise sublethal dose of *V. cholerae* fatal for guinea-pigs on intraperitoneal injection by adding an extract of the mucosa of the small intestine or caecum to the suspension.

In the method described by Griffitts, a 5-hour growth of *V. cholerae* on beef infusion agar is washed off and diluted with physiological saline to a turbidity equivalent to 500 p.p.m. of silica standard. Decimal dilutions are made of this heavy suspension, which contains 2-3 billion organisms per cc. by chamber count. The highest dilutions are made up with 5 per cent mucin, and are injected intraperitoneally as test doses into groups of young white mice weighing 12-14 gm. This addition of mucin to a suspension of a virulent strain of *V. cholerae* increases its killing power for young white mice at least a thousand-fold. On the basis of tests with mucinized suspensions, one other of our six original strains was replaced by an Inaba-type strain received from the National Institute of Health at Washington. All six strains now used in the manufacture of Connaught Laboratories vaccine will regularly kill within 72 hours at least 60 per cent of young white mice injected intraperitoneally

with 500,000 mucinized vibrios. The pathology in mice thus killed is a septicaemia similar to that already described for mice given saline suspensions of living organisms.

The National Institute of Health at Washington has tentatively outlined (12) a mouse protection method of assaying the antigenic potency of cholera vaccine. The method involves vaccinating each of a group of at least 30 white mice, about five weeks old and weighing 8-10 gm., with a single intraperitoneal dose of the test vaccine, equivalent to about 400 million vibrios. Such a dose is represented by 0.25 cc. of a 1:5 dilution of a vaccine standardized to contain, for human use, approximately 8 billion organisms per cc. An equal number of similar mice is set aside at the outset for control purposes. Fourteen days later one-half of the mice in both the vaccinated and non-vaccinated groups are given intraperitoneally approximately 500,000 live vibrios of a virulent Inaba-type strain suspended in mucin, while the remainder receive similar doses of a virulent Ogawa-type strain. The suggested requirement is that at least 50 per cent of the mice in each vaccinated group should survive for 72 hours, while at least 75 per cent of the non-vaccinated mice should die of cholera septicaemia within 72 hours. In other words, a satisfactory vaccine should confer protection upon 25 per cent of mice receiving a single injection thereof. Application of this test to two recent lots of vaccine prepared for distribution showed, for one lot, over 50 per cent protection against both the Inaba and Ogawa-type strains; while the other lot gave 73 and 80 per cent protection against the Inaba and Ogawa-type strains respectively. The former of these 2 vaccines, which gave less satisfactory mouse protection, showed a better "O" agglutinogenic capacity for rabbits.

The mouse protection test would be statistically more satisfying if at least one minimal lethal challenging dose could be used. This would presuppose, however, the acquirement by the mice under test of a higher degree of protection than is conferred by a single injection of vaccine. The possibility of obtaining more clear-cut protection in mice given two spaced injections of vaccine is now being investigated. There would still be no assurance that such a mouse protection test furnished a reliable index of the value of the vaccine for human immunization. In the absence of such known correlation, it would seem reasonable to require that before release for human use, cholera vaccine should show satisfactory agglutinogenic and mouse-protecting properties.

SUMMARY

1. Methods of *V. cholerae* preservation are described with reports on quantitative survival.

2. Injection of heat-killed, phenol-killed, and formalin-killed *V. cholerae* suspensions into rabbits resulted in the highest and best maintained "O" and "OH" titres being evoked by phenol-killed vaccine.

3. Formalin, in a final concentration of 0.5 per cent, interferes with "O" agglutinin titrations.

4. A method is described for production of phenol-killed cholera vaccine.

5. The average "O" and "OH" agglutinin responses in rabbits to five separate lots of phenol-killed cholera vaccine ranged from 1:120 to 1:500, and from 1:1,170 to 1:2,000, for the "O" and "OH" agglutinins respectively.

6. Admixture of cholera vaccine with T.A.B.T. occasioned no significant loss in the capacity of the mixture to produce typhoid and cholera "O" and "OH" agglutinins in rabbits.

7. Administration of cholera vaccine to rabbits by intravenous and subcutaneous routes, in two or three doses at weekly intervals, showed that the best average response followed a series of three intravenous injections. The agglutinins rapidly disappeared from the blood stream irrespective of the route of administration and the number of doses of vaccine.

8. The pathological lesions resulting from a lethal dose of *V. cholerae* injected intraperitoneally into mice are those of a septicaemia, a characteristic gelatinous exudate containing *V. cholerae* being found in the upper half of the small intestine.

9. Vaccinated mice challenged with 2 m.l.d.'s of a saline suspension of *V. cholerae* died more quickly than unvaccinated controls, possibly owing to an overwhelming toxaemia in the former group, resulting from an accelerated and massive bacteriolysis.

10. The feasibility of using mucinized suspensions of *V. cholerae* in the selection of virulent strains for vaccine production, and in the performance of mouse protection tests for antigenic assay of such vaccines, is confirmed.

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EDITORIAL SECTION

THE CANADIAN NUTRITION PROGRAM

JANUARY has witnessed the inauguration of a national nutrition program for the first time in Canada. With technical information available from the Division of Nutrition Services of the Dominion Department of Pensions and National Health, with publicity direction from the Wartime Information Board, and with impetus furnished by the Association of Canadian Advertisers, a great deal of attention to nutrition has been given in the press and on the radio. All of the messages have been designed to awaken Canadians to the need of adequate nutrition for the maintenance of health and physical efficiency.

The national nutrition program has arisen, logically, from the dietary surveys carried out in Canada. All of these showed that there were deficiencies of minerals, such as calcium and iron, and of various vitamins. The aim of the nutrition program is to prevent such dietary deficiencies by urging an increased consumption of the protective foods which must be relied on to furnish minerals and vitamins. The continued cooperation of public health organizations in this plan to improve nutrition is urgently needed.

Certain precautions in nutrition education should be kept in mind. Nutrition is not the only factor concerned with health and should never be presented to the public in that light. Properly, it is an essential part of a health program. This is particularly true for nutrition training in schools. Children are the most fruitful subjects for teaching nutrition; it is particularly important to present nutrition in schools as part of health training and not as a separate subject. Moreover, every care should be exercised to provide information based on sound, scientific evidence. In the preparation of material for the general public it will be necessary to remember that many persons, particularly women, have become familiar with elementary nutrition and are now looking for more advanced information. They will not be satisfied with a simple pamphlet which was useful five years ago.

The war has given great impetus to the recognition of nutrition as an important part of a health program but the conditions which have made possible this realization are bringing difficulties in accomplishment. Problems of supply are becoming acute. Milk, the first thought of every nutritionist,

is short in supply in several communities. Stocks of meat are becoming low. The cheapest source of vitamin C, canned grapefruit juice, is now non-existent in Canadian grocery stores. All of this calls attention to the ramifications of nutrition and may even force a change in educational material. It will be of little avail to urge people to use foods which they cannot buy. It should not be forgotten that this is not a new situation, although the cause is now different. During the depression a large section of the population was unable to secure proper supplies of protective foods because of a lack of money. The spending power of Canadians has reached now the highest peak in history but supplies of food are short. An educational program will have lessened value unless it is made part of a national nutrition policy embracing production and distribution. The splendid success in actually improving nutrition in Great Britain under drastic war conditions has been due to the control of production, distribution, and education under one ministry. The benefits of such a policy must be an inspiration to other countries, including Canada.

Discussion of a national nutrition program would be incomplete if there were no mention of official activities other than education. The Foods Administration has an advisory committee on nutrition to which questions affecting nutrition are referred. This committee has set up a scale of minimal food requirements, below which supplies cannot diminish without danger of nutritional deterioration. The implementation of this scale of food requirements as a definite Government policy can make possible the supply of protective foods emphasized in the education campaign. The coordination, in this way, of nutritional needs with production and distribution is the method which has proved so successful in Great Britain and which is an urgent necessity in Canada under war conditions.

The Canadian Journal of Public Health

WHEN the Act of Confederation was written in 1867, the phrase "public health" was not in use. It is interesting to recall that the first Public Health Act to be passed in any country was the legislation establishing the General Board of Health of Great Britain in 1848. Today "public health" is on the lips of governments and peoples alike. Readers of the JOURNAL will agree that the re-arrangement of the words of the title centres the attention on "public health". There is a growing recognition that medicine is a unity and in practice the preventive and the curative services cannot be separated. The general practitioner must be the health supervisor of the families who are under his care. Preventive medicine and public health are the vital concern not only of the official health authorities but also of every practising physician.

ABSTRACTS OF PAPERS

PRESENTED AT THE ELEVENTH ANNUAL CHRISTMAS MEETING OF THE LABORATORY SECTION, CANADIAN PUBLIC HEALTH ASSOCIATION, HELD IN THE ROYAL YORK HOTEL, TORONTO, ON THURSDAY AND FRIDAY, DECEMBER 17 AND 18, 1942*

Preparation and Standardization of P. P. D. Johnin—C. W. McINTOSH and H. KONST, Division of Animal Pathology, Science Service, Dominion Department of Agriculture.

JOHNIN P.P.D., used for the early diagnosis of Johne's disease (paratuberculosis) of cattle, is prepared from cultures of Johne's bacillus, by a process of ultra-filtration and precipitation. The methods of manufacture and standardization are described.

Serologic Types of Haemolytic Streptococci in Scarlet Fever in Ottawa—E. T. BYNOE, Laboratory of Hygiene, Department of Pensions and National Health.

THE incidence and seasonal distribution of serologic types of *Streptococcus pyogenes* in scarlet fever in Ottawa, during the period September 1940 to February 1942, is reported. During this period 991 cases of scarlet fever were reported, of which 957 (96.5 per cent) were bacteriologically examined.

From throat swabs taken on admission, haemolytic streptococci (Lancefield Group A) were recovered from 893 (93.4 per cent).

Of 897 cultures of *Streptococcus pyogenes* isolated from these 893 cases, 890 (99.2 per cent) were successfully typed. The routine method of typing used was the Griffith slide agglutination test, supplemented in many instances by the Lancefield M- precipitin test and certain biochemical tests.

Types 17, 23 and 26 could not be differentiated by the agglutination test and a strain is described which gives the agglutination reactions of these Types 17, 23 and 26 and a specific M- precipitin reaction with Type 19.

The results of the typing are given in the following table:

	SEROLOGIC TYPE											
	1	*2*	*3*	*4*	*6*	*9*	*11*	*14*	*17*	*19(17)*	*25*	*Untyped*
Number of strains isolated	8	58	513	73	52	5	9	30	2	137	1	9

Type 3 was the predominant strain during the first twelve months of the investigation, while Types 6 and 19(17) were predominant during the winter of 1941-42 (December-February).

The source of the introduction of these Types 6 and 19(17) into the Ottawa community is suggested and the inevitability of spreading new and epidemic strains of scarlatinal streptococci by the movement of large bodies of young adults from training camp to training camp as occurs in wartime is stressed.

**A number of other papers presented at the meeting and not given in abstract form here will appear in full in subsequent issues of the* JOURNAL.

Complication rates for the different serologic types are also reported but the differences are not statistically significant.

This work was made possible through the kind cooperation of the Director and staff of the Strathcona Isolation Hospital, Ottawa.

The Preparation and Preservation of Typhoid V Suspensions for the Agglutination Test—J. M. DESRANLEAU, Division of Laboratories, Ministry of Health and Social Welfare of Quebec, Montreal.

HIGHLY agglutinable suspensions of *Eb. typhosa* V were prepared in 75 per cent alcohol. These suspensions kept well for months in alcohol; but when, after centrifugation, the bacteria were resuspended in distilled water and in glycerol-saline solution they slowly lost their agglutinability by V serum; in saline solution they not only lost their agglutinability by V serum, but also rapidly became agglutinable by O serum.

A method is described for preparing, in 75 per cent alcohol, a stock suspension of *Eb. typhosa* V from which may be prepared, for routine work, suspensions in buffered glycerol saline.

Coliform Organisms found in Private Wells—E. H. GARRARD, Department of Bacteriology, Ontario Agricultural College, Guelph.

FOURTEEN hundred samples of water from private wells in Ontario were analysed to determine to what extent the rapid method of confirming lactose broth presumptives by the use of brilliant-green bile detected coliform organisms claimed to be indigenous to soil, grain, and organic matter.

The presumptive, partially confirmed and completed tests, including lactose brilliant-green bile, were used, followed by differential tests constituting the "I M ViC" reactions. Other tests, including incubation at 44° C. in lactose broth, were used.

From a total of 174 lactose positives inoculated into brilliant-green bile and streaked on eosin-methylene-blue agar plates, 48 failed to produce gas in brilliant-green bile broth. Of these, 26 showed no growth on the plates and the remainder showed little, atypical growth.

One hundred and twenty-six lactose positives produced gas in corresponding brilliant-green bile tubes with good, but not necessarily typical growth on eosin-methylene-blue agar plates. New eosin-methylene-blue agar plates were streaked from the brilliant-green bile tubes, the organisms isolated on slants and then subjected to differential tests. Of these 126 pure cultures, 47 proved to be *Esch. coli*, Types I and II; 47 were *Aer. aerogenes*, Types I and II, and 32 were Intermediates, Types I, II and IX. Forty-two of the 47 *Esch. coli* cultures fermented lactose broth with gas at 44° C. Only one of the remaining 79 *Aer. aerogenes* and Intermediate cultures showed gas in lactose broth at 44° C.

According to these tests, 62 per cent of the organisms isolated by the lactose brilliant-green bile method were types other than *Esch. coli*, Types I and II. As many of the *Aer. aerogenes* and Intermediate types were isolated from samples of water apparently close to contaminating intestinal sources, it is suggested that

until these types are definitely proved to be of soil or grain origin, they should still be regarded as indicative of faecal pollution.

The Effect of Glucose on Penicillin Potency Tests—A. G. LOCHHEAD and I. TIMONIN, Division of Bacteriology and Dairy Research, Science Service, Department of Agriculture, Ottawa.

IN tests of penicillin potency of culture fluids of *Penicillium notatum*, using the serial dilution method, much higher values were obtained with 1 per cent glucose broth than with plain broth used for growth of the test organisms (staphylococci). A less pronounced effect was noted with sucrose, though lactose or mannose, used at the same concentration, were without effect.

When added to actively growing broth cultures of staphylococci, glucose markedly increased the antibacterial action of penicillin, which effect may be bactericidal as well as bacteriostatic. This was noted in tests with culture fluids of the mold and with a preparation of penicillin powder. The antibacterial effect varies with the strength of penicillin, strain and concentration of the test organism, and with time. The results emphasize the importance of uniformity in procedure for evaluating penicillin.

Comparison of Neutralization and Complement Fixation Tests for Western Encephalomyelitis—CHAS. A. MITCHELL and J. WM. PULLIN, Division of Animal Pathology, Science Service, Dominion Department of Agriculture.

EXAMINATION of sera from Manitoba, Ontario, and Quebec by the neutralization test and the complement fixation test gave an opportunity of comparing the results of the two methods. An examination of over 1000 sera failed to demonstrate a marked agreement between the results.

Examination of Sera from Persons resident in Manitoba, Ontario and Quebec for Neutralizing Antibodies of Encephalomyelitis—CHAS. A. MITCHELL and J. WM. PULLIN, Division of Animal Pathology, Science Service, Dominion Department of Agriculture.

THE method of examination is discussed. Specimens of blood from contacts were collected in Manitoba in an area where encephalomyelitis had appeared a year ago, also from an area where clinical cases were infrequent. Neutralization demonstrated the presence of a considerable number of persons possessing neutralizing substances, who had shown no clinical symptoms. As a check a similar examination was made of blood from persons in the Province of Ontario where only two were found to possess these antisubstances. Blood collected in the Province of Quebec failed to show any person possessing neutralizing antisubstances.

Recovery of Equine Encephalomyelitis Virus (Western Type) from Human Spinal Fluid in Alberta—RONALD GWATKIN and IRVIN W. MOYNIHAN, Division of Animal Pathology, Science Service, Dominion

Department of Agriculture (Veterinary Research Laboratory, Lethbridge, Alberta).

EQUINE encephalomyelitis virus (Western type) was recovered from cerebrospinal fluid on the tenth day of illness. The patient recovered. The virus was identified by intracerebral injection of normal and vaccinated guinea pigs (Western type vaccine). It produced paralysis and death in guinea pigs two days sooner than stock viruses for the first few months after isolation, but after guinea-pig passages for a year it paralleled them in virulence. The virus was not titrated at time of isolation but five months later the M.L.D. of guinea pig brain was 0.2 cc. of a 1:40,000 dilution. Filtration reduced the virus content of a brain suspension but the next unfiltered passage showed the previous virulence. The same sample of cerebrospinal fluid, from which the virus was recovered, and a sample of serum from a bleeding made the same day, both neutralized 10 M.L.D. of virus of equine origin after they had been held for six days at about 8° C. The test dose proved fatal for the negative serum control guinea pigs. The points of interest are the recovery of virus on the tenth day of illness and the presence of both virus and neutralizing antibodies in the same sample of cerebrospinal fluid.

Epidemiological Study of Intestinal Intoxication of Babies in General Hospital Nurseries—W. B. MCCLURE, Division of Laboratories, Department of Health of Ontario.

AN epidemiological and bacteriological survey has been conducted on infants in nurseries suffering from acute infectious intoxication of the new-born.

Close association between infant feedings and bowel discharges, as well as faulty techniques, are potent sources in the spread of this infection.

Pathological findings in fatal cases point to an acute intoxication rather than an infectious process.

Bacteriological work is being conducted on colon organisms isolated from affected infants and their ability to produce toxins.

Concentration and Purification of Influenza Virus—RONALD HARE, LAURELLA MCCLELLAND, and JEAN MORGAN, Connaught Laboratories, University of Toronto.

WHEN allantoic fluid infected with influenza A virus is frozen and allowed to melt slowly without agitation, a white flocculent precipitate settles out, leaving a clear supernatant. The bulk of the virus is adsorbed on the precipitate and may be eluted by the addition of buffer of pH 6.0. In this way it is possible to concentrate and purify the virus.

Dilution Method for in vivo Titration of Diphtheria Toxoid—C. SIEBENMANN, Connaught Laboratories, University of Toronto.

DURING an investigation of the antigenic properties of diphtheria toxoids, a quantitative estimation of antigenicity was attempted by using the following scheme.

Forty guinea-pigs (240-280 gms.) receive subcutaneously the following injections:

10	guinea-pigs—	5	cc.	undiluted toxoid
10	" " —	1	"	" "
10	" " —	1	"	toxoid, dil. 1:5
10	" " —	1	"	" dil. 1:25

After five weeks the weights are recorded and all animals are injected subcutaneously with a dose of diphtheria toxin large enough to kill 100 per cent of a group of normal guinea-pigs (of about the same weight). Deaths are recorded up to the 7th day after the toxin injection. The dose of toxoid which gives 50 per cent protection is graphically determined by plotting per cent survival against the logarithm of the toxoid dose.

One toxoid was used as a tentative standard. Part of this same toxoid was frozen and dried in vials.

For a number of toxoids tested during the period 1937-1939, a comparison was made between antigenicity as measured by the 50 per cent protective dose and the Lf units. It was found that the toxoids differed more widely in antigenicity than the Lf units would suggest.

In the above described form, the method does not give any information on the antigenic value of a toxoid used as a secondary stimulus.

In confirmation of previous findings by Prigge, it proved to be essential to use for such quantitative studies uniform, inbred animal stock.

Use of the Waring Blendor to Separate Small Parasites from Tissues*—A. MURRAY FALLIS, Department of Pathology and Bacteriology, Ontario Research Foundation, Toronto.

ISOLATION of young parasitic larvae from tissues, by means of digestion, has not been practical as the larvae may be destroyed and digested sooner than the tissues themselves. Work of McCoy and others has suggested that partially developed larvae of *Trichinella spiralis* can stand digestion but the young stages are usually killed and possibly digested. Use of the Waring Blendor appears to offer a means of surmounting this difficulty. Larvae have been separated from tissues by placing the latter in a small volume of saline in the apparatus and allowing it to run for a short time until the tissue is broken into small particles. The larvae are then recovered from the mixture by sedimenting with a centrifuge and decanting off the supernatant. Further washing of the larvae in saline, sedimenting and decanting are then carried out to separate them from the tissue debris. The apparatus has been used successfully to separate *Ascaris lumbricoides* larvae from intestine, liver and lung tissues and *Trichinella spiralis* larvae from muscle.

Further Studies with H. influenzae, Type B. Part I—COLIN CAMERON and NELLES SILVERTHORNE, Connaught Laboratories, University of Toronto.

A NEW medium consisting of beef liver extract, "staphylococcal filtrate" and immune type B anti-influenzal horse serum incorporated into a base of 3 per

*Demonstration.

cent agar, has been developed. This medium shows a more luxuriant growth of *H. influenzae*, type B, than growth on cooled blood agar. In addition, the medium is clear and a halo formation can be detected around colonies of the micro-organism. The halo reaction in this medium gives the same results as those obtained by Pittman's method of typing with all of the spinal fluid strains tested. Subcultures on this medium are virulent for mice in the mouse mucin test which has been previously described.

Further Studies with H. influenzae, Type B. Part II—NELLES SILVERTHORNE and MYRTLE PATERSON, Connaught Laboratories, University of Toronto.

A STUDY has been made to determine the course of infection in patients with influenzal meningitis caused by *H. influenzae*, type B. The medium used for most of this work in the isolation of strains of *H. influenzae*, type B, was that described in Part I. In certain instances isolation of such strains, with the knowledge that they were type B, could be obtained from the original culture of the nasal swabbing. Nasopharyngeal cultures of groups of adults and children were examined for the presence of the meningeal strain of *H. influenzae*, type B. Only one child in this group harboured a strain of *H. influenzae*, type B. Nasopharyngeal cultures of contacts and of cases of pneumococcal and haemolytic streptococcal meningitis did not reveal the presence of strains of *H. influenzae*, type B. Nasopharyngeal cultures from seven cases of influenzal meningitis showed the presence of *H. influenzae*, type B, in only two patients. Nasopharyngeal cultures of thirty-four contacts of the nine patients with influenzal meningitis revealed the presence of strains of *H. influenzae*, type B, in only six of the contacts.

Food Poisoning—C. E. DOLMAN, Connaught Laboratories (Western Division); Department of Bacteriology and Preventive Medicine, The University of British Columbia; and Division of Laboratories, Provincial Board of Health of British Columbia.

THE incidence of food poisoning is likely to mount as a result of deteriorating standards of simple sanitation, and of the inadequate efforts made to protect comestibles from bacterial pollution. The margin of security against food poisoning hazards resulting from the larger errors of sanitation, always slim, can be maintained only by laboratory control, by supervision and inspection, and by widening the scope and strengthening the application of public health regulations. At present, this margin is in jeopardy, owing to losses in trained personnel, to meagre appropriations, to diversion of public interest, and to over-burdened laboratory facilities. Wartime conditions also tend to multiply food poisonings resulting from faulty personal hygiene. Restaurant employees are continually changing and often untrained; patrons are apt to be less particular; rising costs and impending shortages of food, with diminished refrigeration available, tend to encourage left-overs being picked about and heated up for later consumption; and all these factors promote finger, fly or air-borne contamination.

Salmonella food poisonings are commonly finger or fly-borne, the type of Salmonella involved determining largely whether the main clinical features will be those of an acute gastro-enteritis, of an enteric fever, or of a general septicaemia. But the conception, long held in England, of a "toxin" type of Salmonella food poisoning, characterized by a short incubation period, a transitory illness, negative stool cultures, and a very low mortality rate, is probably erroneous. Healthy human and animal carriers of Salmonella occur, while some types may cause clinical syndromes so mild as to pass unnoticed. Recognition of the susceptibility to Salmonella infection of many domestic animals, including mares, cows, sheep, goats, pigs, dogs, cats, hens, ducks and turkeys, and of the potential pathogenicity for men of many Salmonella strains until recently isolated only from such animals, points to a possibly higher future incidence of a greater variety of food poisoning arising from mass shipments of hastily-inspected cattle, pigs and poultry.

The commonest type of food poisoning, that due to staphylococci, is the hardest to control, owing to the widespread distribution of enterotoxigenic strains, which may be present in the air, on hands, in the nasopharynx and conjunctiva, and in the udder of apparently healthy cows. Basic control measures are pasteurization of dairy products, more extensive use of refrigeration, legislation against exposure of pastries and confections in show windows, and public education regarding the need for a more stringent hygiene of both the institutional and domestic kitchen. However, enterotoxigenic strains are not as common as the results of kitten tests have been thought to suggest. In attempting to throw light on the possible relationship between the beta-toxin ("hot-cold" sheep red cell lysin) and the enterotoxin, staphylococcal filtrates with and without a high beta-toxin content were ingested by human volunteers and injected intraperitoneally into kittens. The results showed conclusively that beta-toxin and enterotoxin are separate entities, either of which alone may provoke a positive kitten reaction.

Filtrates were prepared from a strain of staphylococcus (isolated in England from brawn incriminated in a food poisoning outbreak) which produced no detectable beta-toxin, and also from a spontaneous variant of this strain which was highly beta-toxigenic. The alpha-toxin present in both filtrates was neutralized by addition of appropriate amounts of a monovalent alpha-antitoxin. Doses of 1-3 cc. of the beta-toxin, injected intraperitoneally into kittens weighing 400-900 gms., usually resulted in early and repeated vomiting and diarrhoea (commencing sometimes within 5 minutes of injection), with death occurring several hours later. Similar doses of filtrate from the parent strain often occasioned vomiting and sometimes diarrhoea, commencing ¾ to 2 hours after injection, with complete recovery of the kittens overnight. Kittens refractory to intraperitoneal injections of either the beta-toxin or the enterotoxin were encountered. Amounts ranging from 1-8 cc. of the filtrate containing potent beta-toxin were ingested with impunity by several human volunteers; whereas 1 cc. amounts of the filtrate containing no detectable beta-toxin caused violent vomiting and diarrhoea among the same group. One volunteer proved refractory

to 5 cc. of the enterotoxic filtrate. There was no correlation between the degree of susceptibility to enterotoxin and the titre of circulating beta-antitoxin.

The kitten reactions obtained when boiled staphylococcal filtrates are injected intraperitoneally thus represent the combined effects of residual beta-toxin and enterotoxin. Preliminary neutralization of the alpha and beta-toxin components of test filtrates by appropriate antisera considerably reduced the incidence of kitten reactions following intraperitoneal injection of the mixtures. In experiments of somewhat limited scope, the intravenous administration of 1-3 cc. of such neutralized mixtures into adult cats proved a satisfactory method of eliminating false reactions due to beta-toxin, and also of overcoming the failure of some kittens to vomit following intraperitoneal injection of known enterotoxic filtrates.

Filtrates of some strains of *B. coli, Proteus vulgaris* and of certain other micro-organisms which may be isolated, sometimes in large numbers, from foodstuffs suspected of causing food poisoning, may also evoke a vomiting reaction when injected intraperitoneally into kittens or intravenously into cats. In view of these facts, the food poisoning potentialities of several representative strains of the foregoing were investigated. Filtrates of strains of *B. coli, Proteus vulgaris,* streptococci, and Gram-positive spore-bearing organisms, isolated from incriminated foodstuffs in England several months previously, under the direction of Professor G. S. Wilson, were ingested by volunteers in amounts ranging from 5-50 cc. Filtrates of recently-isolated strains from various local sources were also ingested. No deleterious symptoms resulted in any instance. Meat pies were inoculated with similar organisms, and allowed to incubate until their bacterial count per gram greatly exceeded their population in the foodstuff from which they had originally been isolated. The pies were then consumed by volunteers, again without untoward results. It is therefore believed unlikely that air or finger-borne organisms of these types play any significant role in food poisoning. Their association with foodstuffs causing attacks of the "toxin" type of food poisoning, characterized by early onset of an acute but transitory gastro-enteritis, is believed to be usually that of secondary invaders to a primary staphylococcal intoxication of the food.

Red Cell Degeneration Caused by Substances of the Thiazine Group*—
C. SIEBENMANN, Connaught Laboratories, University of Toronto.

THE formation of refractive globular bodies attached to the red cells is described, appearing during toxic anaemias produced by feeding phenothiazine to mice. During the development of such anaemias, these globules tend to grow in size while the affected red cells gradually lose their normal pigmentation. When using Nile Blue as a vital stain for blood smears, the affected erythrocytes show the globules as dark blue bodies. Such degenerated erythrocytes are readily distinguishable from nucleated red cells and reticulocytes. The size and number of these globular bodies as well as the degree of anisocytosis and poikilocytosis depend upon the dosage of phenothiazine used.

**Demonstration.*

Of interest is the resemblance of the erythrocytes showing the globular bodies with degenerated red cells first described by Ehrlich in certain anaemias of toxic or haemhorragic origin. Similar globules were encountered by Heinz when producing anaemias in animals with phenylhydrazine derivatives.

The examination of vitally stained blood smears, taken at various intervals during phenothiazine anaemias in mice, shows that reticulocyte structure and globular degeneration of red cells are two phenomena which exclude each other, in so far as they are not found side by side in the same cell. The reticulocytes seem to be more resistant than normal red cells against the haemolytic action of thiazines and do not develop globular degeneration.

In addition to phenothiazine three other thiazines, namely thionol, thionin and methylene-blue, were tested for their ability to produce red cell destruction in mice. Phenothiazine proved to be the least toxic. Thionol closely resembled phenothiazine in its action, while thionin and methylene blue led to rapid red cell destruction in much smaller doses (2 mg. per os per 20 g. mouse daily) than phenothiazine (10 mg. daily). In the case of phenothiazine the red cell degeneration was counteracted by a marked reticulocytosis.

The formation of the above-described globular bodies as caused by the administration of phenothiazine was confirmed by feeding to two Rhesus monkeys six daily doses of 0.5 g. of the drug per kilogram body weight. The appearance of the globular bodies in the blood preceded and accompanied the development of a slight anaemia from which the animals readily recovered. Phenothiazine when given in smaller doses (0.05 g. per kilogram), corresponding to the dosage effective in humans against pinworm infection, did not produce distinct changes in the blood picture.

BOOKS AND REPORTS

Ambassadors in White. *The Story of American Tropical Medicine. By C. M. Wilson. New York: Henry Holt, 1942. 372 pages. $3.50 (U.S.A. funds).*

THE title of this book does not by any means indicate its true value and importance, for not only is it a story of disease at its worst and medical pioneers at their best but it teaches vital lessons in economics, national and international. The facts concerning the variety and incidence of disease in Latin America are startling. It is estimated that of a population of one hundred and twenty million people more than one-third are sick. In such a "sick man's society" vast potential resources remain undeveloped, cannot be developed, until plagues and scourges and conditions which beget them are first of all brought under reasonable control. That such a state of affairs has a very direct bearing on the prosperity and welfare of the hemisphere as a whole becomes at once obvious and this interrelationship between public health efforts and economic advancement is forcefully presented.

But the story is not all dark. Great strides have been made towards improved sanitation and disease control and the account of this progress is a vivid one. The conquest of yellow fever, for example, is entertainingly told in the form of biographical sketches of Finlay, Reed, Gorgas, and others. A chapter entitled "Banana Medicine", the story of the United Fruit Company, illustrates the wisdom and necessity of an intelligent medical program for success in commercial ventures in the tropics.

Unfortunately, errors or inaccuracies, typographical and otherwise, are not infrequent: dermatomycoses are referred to as dematomycoses; Gorgas is stated to have visited the Transvaal in 1931, though he died in 1920; typhoid vaccine is mentioned where smallpox vaccine is meant; Brill's disease, apparently a form of epidemic typhus, is called murine typhus, and bubonic plague is spoken of as a louse-borne instead of a flea-borne disease. One feels in reading the chapter on Noguchi that over-enthusiasm is at play and to say that Noguchi was "perhaps the greatest bacteriologist the world has ever known" is to overstate grossly the case. Much of Noguchi's work has not stood the test of time. It must be confessed, however, that these discrepancies and others which could be listed detract but little from the value and interest of the text.

Most of this book is exceedingly interesting and it presents a wealth of significant information. The extensive bibliography, index, and other notes testify to the effort and research which went into its preparation and the author deserves a wide hearing for this very timely and important message.

F. O. Wishart

War Medicine. *Edited by Joseph E. Zbar. New York: The Philosophical Library, 1942. 565 pages. $3.50 (U.S.A. funds).*

THIS book is a collection of fifty-seven articles which have already been published in other journals. Despite its title, no less than 331 out of its 565 pages are devoted to surgery, the remainder of the book being occupied with dealing with aviation and naval medicine and also general medicine. The best section, however, is that dealing with aviation medicine, which includes excellent articles by John Fulton and Alvin L. Darrach.

In the section devoted to surgery, there are excellent papers on wounds of the brain embodying much of the teachings of Cushing, another on burns by Gordon Taylor, a third on plasma protein by Frank B. Marsh, and a fourth on shock by a team headed by L. E. H. Whitby. Nevertheless, the compliers have on the whole seen fit to omit articles which deal more

specifically with the most important advances which have recently been made in the surgery of war.

There is, for instance, no article dealing with closed plaster treatment. There are several written by Trueta himself which would have been admirable. Only two papers are devoted to compound fractures, one by Winnett Orr which is largely historical, reminiscent and irrelevant; and another, of two and one half pages only, by Darrach, in which all the various methods of fixation are relegated to one paragraph. Despite the fact that the sulphonamides are probably of great value in the prevention of gas gangrene and streptococcal infection, the only mention of these drugs is very incidental in papers dealing with general surgery. And the only article on gas gangrene itself is by an author who gives a detailed description of Barber's method of single cell culture but fails to mention other methods of isolation, who ignores McIntosh and Fildes' jar, and is evidently quite ignorant of the fundamental work of Wright, Fleming and Fildes on the pathogenesis of the disease. There is no mention of tetanus anywhere, so that the value of tetanus toxoid is quite ignored. Yet it is generally agreed that the most important advances made in war surgery to date have been in the use of plaster for fixation, the value of locally applied sulphonamides, and in the immunization of troops with tetanus toxoid.

The omissions in the section on general medicine are more serious, for typhus, dysentery, the enteric diseases, venereal infections, and those of the respiratory tract are amongst the most important diseases of war. With the exception of an article on dysentery in which no mention whatever is made of sulphaguanidine, these infections are entirely neglected. But there are, amongst others, papers on the liquefaction of foods, allergy, shamming night blindness, and malingering.

It is of course easy to quarrel with the compilers of any anthology, but in view of the fact that the book is well bound and printed, as well as being relatively expensive, the inclusion of articles which have only a very indirect bearing on the medicine and surgery of war, and the omission of articles dealing specifically with the more important problems of wartime, are, to say the least, unfortunate.

Ronald Hare

BOOKS RECEIVED

Fundamentals of Psychiatry. *By Edward A. Strecker. Montreal: J. B. Lippincott Company, 1942. 187 pages. $3.75.*

A Handbook for Assistant Medical Officers of Health on Child Welfare and School Medical Work. *By F. J. G. Lishman. London: H. K. Lewis & Co., 1942. 70 pages. 6s.*

Laboratory Diagnosis of Protozoan Diseases. *By Charles Franklin Craig, Toronto: Macmillan, 1942. 337 pages. $5.15.*

Introduction to Parasitology. *By A. S. Pearse. Springfield: Charles C. Thomas, 1942. 357 pages. $3.75.*

Introduction to Medical Science. *By Charles G. Darlington and Grace G. Appleton. Montreal: J. B. Lippincott Company, 1942. 446 pages. $3.25.*

Practical Sociology and Social Problems. *By Helen C. Manzer. Montreal: J. B. Lippincott Company, 1942. 366 pages. $3.75.*

Housekeeping Service for Chronic Patients. *By Marat Fraenkel. New York: Welfare Council of New York City. 143 pages. $1.00.*

Annual Report of the International Health Division. *New York: The Rockefeller Foundation, 1942. 224 pages.*

Report of the Victorian Order of Nurses for Canada, 1941. *Ottawa: The Victorian Order, 1942. 100 pages.*